SCIENCE ABSTRACTS.

Section A.—PHYSICS.

NOVEMBER 1917.

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SCIENCE ABSTRACTS.

Section A.—PHYSICS.

NOVEMBER 1917.

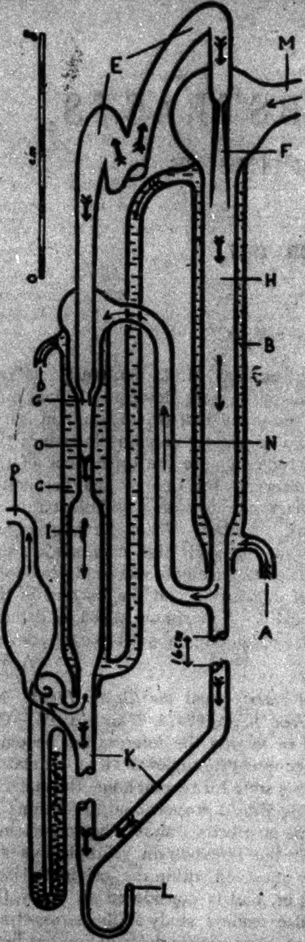
GENERAL PHYSICS.

1211. *Mercury-arc Pump.* **L. T. Jones** and **H. O. Russell.** (Phys. Rev. 10. pp. 301–304, Sept., 1917.)—The pump here described differs only from that of Knipp [Abs. 571 (1917)] in the manner of driving and in introducing and taking off the mercury. Two barometer columns introduce the mercury to the arc, which is started by blowing into the open neck of the Woulff bottle which constitutes the reservoir for one of the barometer columns. The heat of the arc vaporises mercury at a sufficient rate to actuate the pump connected to the arc chamber. With Pyrex glass arc currents up to 30 amps. have been used, but such high currents are not necessary for efficient working. A series of experiments was made to determine the connection between the rate of exhaustion and the current in the arc, and the results are exhibited graphically. A maximum speed, as defined by Gaede's relation $S = (V/t) \log p_1/p_2$ was obtained of about 400 cm.^{3} per sec.

A. W.

1212. *Torsional Deformation of Steel Bars beyond the Elastic Limit.* **M. Majima.** (Math. Phys. Soc., Tōkyō, Proc. 9. pp. 67–74, March, 1917.)—On exceeding the elastic limit of mild steel in torsion the deformation becomes plastic, and with a constant twisting couple the angle of twist ultimately reaches an upper limit. When left in this state for several hours the material recovers its elasticity; the recovery being almost proportional to the time of standing. Increasing the twisting couple now brings about elastic deformation, and up to the new elastic limit the stress-strain relationships are approximately equal to those previously observed within the original elastic limit. This is explained on the basis of, and is considered to verify, the "slip-band" theory. The author has also made a study of the stress-strain loop in torsion. The results indicate that when plastic deformation has been produced in one direction, the elastic limit in the reverse direction is diminished, and may occur at zero stress if the previous deformation has been sufficiently developed. The sum of the lengths of the straight parts of the curve in both directions is practically constant regardless of the max. torsional angles. Repeated cycles, with the same max. stresses, coincide with each other to all intents and purposes. The times required for recovery of elasticity are greater than in the cases where the stress is uni-directional. In the case of twisting in one direction only, recovery of the elastic limit by reheating reaches a maximum at temperature between 300° and 375° C., whereas if the twisting has been reversed the max. recovery occurs at 580° C.

F. C. A. H. L.



1213. *Two-stage Mercury-vapour Pump.* **H. F. Stimson.** (Washington Acad. Sci., J. 7. pp. 477–482, Sept. 19, 1917.)—The "condensation pump" described recently by Langmuir [Abs. 89 (1917)] requires for its operation a primary vacuum of a few tenths of a millimetre of mercury pressure. The desirability of using a water aspirator as a primary pump has led to the further development of the mercury-vapour pump now described. The pump was made entirely of Pyrex glass, which is easily manipulated. The operation of the pump is as follows: Cooling water entering at tube A flows up through the water-jacket B above the lower end of the De Laval nozzle F, up through the water-jacket C above the nozzle G, and out at tube D. Mercury vapour from the boiler, entering through the tubes E, flows through the nozzles F and G, is liquefied in the condensation chambers H and I, falls into the tubes K, and returns to the boiler through the tube L. Gas from a vessel to be exhausted enters at M, flows through nozzle F, is compressed by the jet of mercury vapour in the condensation chamber H, and flows up through tube N to the intermediate pump. From here it flows past the nozzle G and is compressed through O in the chamber I to a pressure measured by the attached manometer, then out by tube P to the water aspirator. Tests of the pump as described indicate a speed, when working against a primary pressure of 4 cm., of about 250 cm.^{3} per sec., the speed S being defined by the relation $S = (V/t) \log (p_1/p_2)$, where V is the volume, t the time, and p_1 and p_2 are respectively the initial and final pressures.

A. W.

1214. *Speed Effect and Recovery in Slow-speed Alternating Stress Tests.* **W. Mason.** (Roy. Soc., Proc. 92. pp. 373–376, May 6, 1916. Abstract.)—In a series of repeated torsion tests of steel it was noticed that when the steel had become fatigued the angular strain became considerably greater when the frequency of the cycles of stress was decreased, and *vice versa*, although the maximum and minimum stresses of the cycle were unchanged. The frequencies used were between 20 and 200 cycles per minute. This effect was absent when the cyclic strains were purely elastic, while it became increasingly apparent as non-elastic strain developed. [See Abs. 628 (1912).]

C. O. B.

1215. *Torsional Resistance of Rolled Joists.* **A. Föppl.** (Zeits. Vereines Deutsch. Ing. 61. pp. 694–695, Aug. 18, 1917.)—A rod twisted by application of a couple M applied at its ends is deformed (within elastic limit) uniformly and in proportion to M. The twist ϑ in unit length $= M/JG$; where $G =$ modulus of shear $= 850{,}000$ kg./cm.^{2} for rolled iron, and J is a factor varying with the form of the section, and of the same dimensions (cm.^{4}) as the moment of inertia of the section. Both analytical and experimental methods are needed to solve the problem of determining the torsional resistance of sections used in practice. The author evolves a formula which he considers will be verified by experimental investigation. Almost all the formulæ hitherto available concerning the torsion of rods, are based ultimately on St. Venant's researches. Some of St. Venant's formulæ are based on rigid mathematical solutions for definite sections; others are empirical formulæ intended to give at least approximate solutions for the torsional resistance of any section. These latter formulæ are less reliable. The older of St. Venant's approximate formulæ for rolled joists is $J = 4J_x J_y / J_p$; where J_x and J_y are the moments of inertia referred to the two principal axes. This formula needs a correction factor which has only been worked out for the simplest cases. The later and more accurate formula is $J = F^4/40J_p$; where $F =$ sectional area. This formula is reasonably accurate for the old standard pattern of I-beam, but fails completely for modern broad-flanged I-beams.

The author's formula is derived from Bredt's (1896) and Prandtl's (1904) works. Most rolled joists may be considered as built up from narrow rectangles with curves where one rectangle runs into another, these additions being, however, of no importance as regards torsional resistance. Sections approximate closely to the limiting case in which the narrow side of each rectangle is indefinitely small compared with the longer dimension, and in that case the torsional resistance of the whole section equals the sum of resistances of the individual rectangles. For a narrow rectangle, measuring l along its greater and d along its less dimension, $J = d^3l/3$. For a rolled joist section, built up from such rectangles, $J = \frac{1}{3}\Sigma d^3l$. This formula is not strictly true, because it is based on the unrealised assumption of infinitely thin rectangles. It is, however, a good approximation, capable of correction by factors determined by experiment. A simple formula for the max. shear stress ($S_{max.}$) set up in the section by the couple M, is $S_{max.} = 3Md_{max.}/\Sigma d^3l$; where $d_{max.}$ represents the smaller dimension of the thickest rectangle in the section.

R. E. N.

1216. *Mechanical Theory of the Hardness of Metals.* **K. Honda.** (Tôhoku Univ., Sci. Reports, 6. pp. 95–99, July, 1917.)—For a given substance having a definite molecular force, its hardness increases with the fineness and the strained state of structure; for the same structure and the same degree of strain, the hardness of a substance increases with the strength of its molecular force.

C. O. B.

1217. *Spontaneous Fracture in Tempered Steel.* **G. Colonnetti.** (Accad. Sci. Torino, Atti, 52. 5 and 6. pp. 287–289, 1916–1917.)—Describes an interesting case of spontaneous fracture (during storage) of a grenade head composed of tempered nickel-chrome steel containing 2·4 % Ni, and 0·78 % Cr. Photomicrographs are given of the fractured surfaces. J. W. T. W.

1218. *Lateral Vibrations of Bars of Variable Section.* **J. W. Nicholson.** (Roy. Soc., Proc. 93. pp. 506–519, Sept. 1, 1917.)—Deals mathematically with the fundamental bi-nodal vibration of a laterally vibrating free-free bar formed of two equal halves fitted together at the thicker end, the whole bar being a solid produced by the revolution of the curve $y = Ax^n$ about the axis of x. L. H. W.

1219. *Failure of Poisson's Equation for certain Volume Distributions.* **G. Prasad.** (Phil. Mag. 34. pp. 138–142, Aug., 1917.)—The author works out mathematically three cases where the equation fails. L. H. W.

1220. *Critical Loads for Long Tapering Struts.* **A. Morley.** (Engineering, 104. pp. 295–298, Sept. 21, 1917.)—This article illustrates in some detail a method devised by the author for obtaining critical loads for long tapering struts. In a previous article [*ibid.* 97. p. 566, 1914] he had already dealt with the question of varying section generally, but Bairstow and Stedman [Abs. 1781 (1914)] in a later paper criticised the method as difficult, unless the variation of section took one or other of certain specified forms. The present author does not agree with their view and this article is the result. W. J. C.

1221. *Vibrations under Variable Couplings quantitatively elucidated by Simple Experiments.* **E. H. Barton** and **H. M[ary] Browning.** (Phil. Mag. 34. pp. 246–270, Oct., 1917.)—The paper describes two types of coupled pendulums which are considered useful both for lecture demonstration and for quantitative work in the laboratory, especially as they illustrate many important points in the phenomena of inductively-coupled electrical circuits.

One of these, called the double-cord pendulum, is like a pair of Blackburn's pendulums in parallel planes, connected by a stiff tube at the droops of the bridles. Its vibrations occur perpendicularly to these parallel planes. It may be used with couplings gradually varied from very loose to very tight, say from 1 to 60 %. (The coupling is loose when the bridle is very tight, and *vice versa.*) It exhibits, by double sand-traces simultaneously formed on a moving board, the gradual change of the vibration from the phenomena of slow beats (for very loose coupling) to those of compound harmonic motion (for very tight coupling). Most of the curves, however, show the superposition of two simple vibrations of incommensurable frequencies. The pendulum shows also the effects of different initial conditions. This form is specially suitable for laboratory work, as it may be set up from the simplest materials and yet give results of distinct and quantitative value. If the lengths are equal and the masses also (as used in the present experiment), then the vibrations are quite interchangeable. Photographic reproductions are given of 16 double traces obtained with this pendulum.

The other form of apparatus, or cord and lath pendulum, is yet easier to use for simple lecture illustration, but requires more careful installation for the best work in the laboratory. It consists of a simple pendulum, with a light lath for its rod, from a movable stud on which hangs the cord pendulum. The coupling is loose when this stud is high on the lath, and tight when it is low.) Even if the lengths are made equal, and also the masses, the vibrations of this pendulum are not interchangeable. The effects of various initial conditions are accordingly more striking. This form may be used for couplings varying from about 10 to 55 %. Photographic reproductions are given of ten single and four double traces obtained with this pendulum.

The mathematical theories of both pendulums are developed and compared with each other, and with the theory of the electrical case it is sought to represent. The experiments are in satisfactory agreement with theory, though this is not always immediately obvious.

In the experiments and most of the theory the lengths of the pendulums have been equal and also the masses of the bobs. A large field lies ready for exploration in the cases where the quantities of one or both classes are unequal and varied at will. These cases are reserved for later papers.

E. H. B.

1222. *General Expansion Theorem for the Transient Oscillations of a Connected System.* **J. R. Carson.** (Phys. Rev. 10. pp. 217-225, Sept., 1917.)—In the usual solution of the problem of the transient oscillations of a connected mechanical or electrical system in response to a suddenly impressed set of forces, the determination of the characteristic modes of oscillation (periodicities and dampings) is comparatively easy, since it involves only the determination of the roots of a polynomial. But the determination of the amplitudes of the transient oscillations is extremely laborious, and the difficulty increases rapidly with the number of degrees of freedom of the system. Heaviside, in his "expansion theorem," has given a valuable formulation of the transient oscillation of an electrical network when the oscillations are excited by the sudden application to the system of an e.m.f. which is not a function of the time, *i.e.* a steady uniform e.m.f. In the present paper the general solution of the problem considered by Heaviside is developed, and an expansion theorem is derived which formulates the resultant (forced and transient) oscillations of a connected dynamical system in response to an arbitrary driving force applied to any coordinate of the system. The only limitation imposed on the form of the driving force is that it shall be capable of expansion in a Fourier's integral or else be expressible as a complex exponential function of time, a limitation which constitutes no restriction of practical importance. The expansion theorem derived is thus of broader application than Heaviside's theorem, which constitutes a particular case. The chief utility of the theorem resides in the fact that by its use the solution for the transient oscillations of the system considered is reduced to formulæ which are functionally the same as those for steady-state oscillations. A. W.

1223. *Equilibrating Rotating Masses.* **A. Capetti.** (Accad. Sci. Torino, Atti, 52. 14. pp. 598-606, 1916-1917.)—The author points out that the stroboscopic phasemeter of Ricci [Abs. 982 (1916)] presents two principal defects. The first is the thickness of the images of the pointer and of the scale; the second, the small angle at which the two images cut one another when the amplitudes of the movements are small. The first defect can only be avoided by adopting an optical method, but its importance can in all cases be diminished by diminishing the second, which is by far the most important. A method for obtaining this diminution consists in amplifying the movements both of the pointer and of the disc. But although this can be easily obtained in the case of the pointer, it is difficult with the disc. The author examines, therefore, whether the stroboscopic curve obtained by amplifying only the vibrations of the pointer can be utilised and what properties it possesses. He demonstrates that the phase and amplitude of the movement can be exactly obtained from the new curve and that it presents, in addition to the advantage above cited, certain advantages for the readings near the centre of the disc. A description of the amplifying apparatus is then given; it is essentially composed of a lever of the first kind with unequal arms, the ratio of which can be varied.

To avoid the use of material masses, the inertia of which is troublesome, the author suggests an optical device, founded upon the reflection of light. The displacement of a mirror causes a larger displacement of the image of a luminous source reflected by the mirror: the latter image can give the phase and amplitude of the movement. E. B.

1224. *Equilibrating Rotating Masses.* **A. Capetti.** (Accad. Sci. Torino, Atti, 52. 15. pp. 656–660, 1916–1917.)—In this note the author suggests a practical method for equilibrating a rotating mass by using the amplifying stroboscopic phasemeter already described [see preceding Abs.]. Ricci has already given the theory of the operations necessary to equilibrate a rotating mass [Abs. 982 (1916)]. Two cases are to be distinguished, viz., whether the mass is or is not possessed of a plane of symmetry perpendicular to the axis of rotation. In the first case, the two nodes of vibration are at finite distance; to determine them two phasemeters are placed each at each end of the shaft and one of the two resonance speeds is given to the mass: the two phasemeters will give the phases and the amplitudes of the oscillations at the ends of the shaft. Tracing these in a given scale in the drawing of the mass, the intersection with the axis of the shaft of the straight line joining the extremities of the segments representing these oscillations, will be one of the nodes. Giving to the mass the second resonance speed and proceeding in the same manner the position of the second node will be obtained. Giving then to the mass the same angular speed but the reverse direction, the phasemeter will give another reading: the mean of this and of the former reading will give the phase of the force acting upon the second node. Applying then a known exciting force by displacing to a known extent known masses, a new resultant force in the second node will be obtained. Proceeding in an analogous manner, the phase and amplitude of this new force can be obtained, and consequently it can be equilibrated by displacing the movable masses. In the same manner the equilibrating of the exciting force acting upon the first node can be proceeded with.

In the second case, viz. when the rotating mass is possessed of a symmetry plane perpendicular to the axis of rotation, it is not necessary to determine the position of the nodes, as it is known that one of them is at the centre of the rotating mass and the other is at infinite distance. The equilibrating of the rotating mass is obtained as in the former case.

A practical example of the second case is then given. E. B.

1225. *Work of the National Physical Laboratory in* 1916–17. (Report [67 pp.], Teddington, 1917. Abstracts in: Engineering, 103. pp. 598–599, June 22; 623–624, June 29; 104. pp. 4–5, July 6, and pp. 33–35, July 13, 1917; Electrician, 79. pp. 550–551, July 6, 1917.)

1226. *Report of the Committee of the Privy Council for Scientific and Industrial Research for the Year* 1916–17. (Electrician, 79. pp. 899–901, Sept. 7, and pp. 936–937, Sept. 14, 1917. Abstract. Engineer, 124. pp. 179–180, Aug. 31, and p. 206, Sept. 7, 1917.)

1227. *An Analysis of Model Screw-propeller Experiments.* **S. Motora.** (Engineering, 103. pp. 555–557, June 8, 1917. Abstract of prize essay read before the Japanese Soc. of Naval Architects.)

1228. *Motion of a Spinning Projectile.* **J. Prescott.** (Phil. Mag. 34. pp. 332–360, Oct., 1917.)—For solving the problem of a projectile's motion, a formula is necessary giving the resistance of the air to a body moving through it. Bashforth assumed the resistance to vary as the cube of the velocity, the main reason for this choice being that it was the easiest to work with mathematically. Actually the cubic law is very remote from the truth except over two very small ranges of velocity. Bashforth's method was to express resistance in the form K_vV^3, V being the velocity of the projectile, and K_v a variable which is treated as a constant in his mathematical theory, the errors introduced in consequence of this incorrect assumption being kept small by his dividing the path into small portions and using a different K in each portion. From Bashforth's own results, however, which are based on observations, the resistance of the air is much more nearly proportional to the square of the velocity except between 900 and 1200 ft. per sec. If R denote resistance and R/V^2 be plotted against V, the curve is very nearly horizontal for velocities below 800 ft. per sec., then rises rapidly to $V = 1800$ ft. per sec., after which it is nearly horizontal again. The steepest part is near where $V = 1080$ which is about the velocity of sound. The author opines that it is reasonable there should be a change in the law of resistance at the velocity of sound, for, when the projectile velocity is less than that of sound, the particles encountered by it at any instant had already been set in motion before the projectile arrived, by the pressure which was transmitted ahead of it, this pressure being transmitted with the velocity of sound. When the projectile is travelling with velocity greater than that of sound no pressure waves are transmitted ahead, so that the projectile meets, and has to set in motion, stationary air particles. This change in the behaviour of the air is shown in photographs of flying bullets. Bashforth also states that his observations show that the resistance of the air is exactly proportional to the area which the shot presents to the air in its motion. This means that the resistance to elongated shot, which travel nose foremost, is proportional to the square of the diam. of the shot. From a curve showing the relation between resistance, velocity, and diam. for an elongated shot, it is seen that the resistance is fairly well represented by assuming that $R = KV^2$ or $R = K_1V^2$ according as V is greater or less than 1060 ft. per sec., K and K_1 being constants. It is shown in the paper that very good agreement with Bashforth's tables, as well as with the range tables for bullets, can be obtained on these assumptions. The equation to the trajectory is first determined, the assumption being made that the area presented to the air by the shot in its flight is constant, which amounts to assuming that the shot always travels nose foremost with its axis exactly in the direction of the line of flight. The extent to which this assumption is in error is dealt with in the latter part of the paper where the motion of the axis is investigated. The application to the Mark VII bullet next receives attention. The constants for the Mark VI bullet are then determined and the results for both VI and VII tabulated. The motion of the axis of the shot is the subject of an exhaustive mathematical investigation. The behaviour of the axis of the shot cannot be foreseen from that of a spinning top, since in the case of the top, the force acting on it, namely, gravity, acts in a fixed direction, whereas the resistance to a projectile rotates with the line of flight. In this paper it is shown that the axis pursues the line of flight while lagging a little behind it, the angle of lag increasing with the range. Moreover, the axis of a shot having right-handed spin is deflected a little to the right (and for left-handed spin, to the left) of the line of flight. The action of the air on the side of the shot exposed by the deflection of the axis causes a shot with right-handed spin to veer bodily to the right, giving the deviation called drift. In the present investigation the drift, as well as the deviation due to a side wind, is determined as far as possible. The effect of the wind is already known, and is given in Greenhill's "Notes on Dynamics," but the theory of drift does not seem to be well known, for Greenhill's proposed formula for it, for which, however, he claims no theoretical basis, differs very considerably from the result arrived at in this paper. Since the drift has been calculated in this paper from the same differential equations as the wind effect, and the formula for the latter is known to be correct, this should give confidence in the calculated drift. Tables are given for Marks VI and VII bullets.

Although the numerical results will have to be modified to suit shells, it is clear from the results worked out that the spin of a shot carries out very faithfully the task of keeping the nose foremost during the flight, and that the deflection of the axis is less at effective ranges for the larger shot than for the smaller ones. H. H. Ho.

1229. *The Positive Nucleus of the Atom.* **A. Haas.** (Phys. Zeits. 18. pp. 400–402, Sept. 1, 1917.)—Among other qualities, the Rutherford atomic theory [Abs. 1487 (1915)] furnishes the method for determining the total mass m_e of electromagnetic material, since with a sphere of radius r and electric charge Q we obtain $-\mathrm{L}m_e = 2\mathrm{Q}^2/3c^2a$. In consequence the mass of the positive nucleus of the atom can be determined when the other quantities are substituted in this equation. A further conclusion to be derived from the above expression is a relationship between the atomic weights of different atoms and the radii of their nuclei, and, since the volumes of the nuclei are directly as the third power of the atomic weights, the density of the positive electricity in the nuclei is therefore inversely proportional to the third power of the atomic weights. The latter conclusion appears to be so improbable that the author sets forth in the present paper his proposals for avoiding the above difficulty. He assumes that in a similar way to negative electrons there are individual positive charges on quanta elements of fixed radii which are appropriately chosen so that in connection with the above formula the value of the mass of the hydrogen atom follows. The radius of such a positive electron must in consequence be about 1800 times smaller than that of a negative electron. A new difficulty has now to be solved with regard to the nature of the forces between the positive electrons in the nucleus. A third difficulty arises out of Rutherford's hypothesis, in that the charge of the positive nucleus in nowise amounts to so many positive quanta as would correspond to the atomic weight of the element concerned, but only to about half that number. The author after discussing these difficulties puts forth a hypothesis for their removal as follows:—Let the atomic weight of a particular element be r; the nucleus, however, behaves as if it contained only s positive quanta, which number s, according to Rutherford, is only about $\frac{1}{2}r$, although the assumption may nevertheless be made that the atomic nucleus may be composed of r positive electrons whose mass must be r times as great as m_H, the mass of the hydrogen atom, and equal to the product of m_H and the atomic weight. The total mass of the negative electricity in the atom must also equal r quanta elements, and the remaining $(r-s)$ negative elements should therefore serve to bring about the union of the r positive electrons to a single nucleus, which would then possess a charge of r positive and $(r-s)$ negative quanta. It would therefore act with a positive charge of s quanta and at the same time possess the mass $r \cdot m_H$. About this nucleus the s mobile negative electrons would describe definite orbits in the sense of Bohr's theory.

The author shows that on this hypothesis a simple interpretation of the Moseley formula for the K_a line of the Röntgen spectrum becomes possible by the transition of a negative electron from a triple quanta to a double quanta orbit. Similarly the L_a line may be explained. Finally the nature of the union of the positive electrons by negative electricity is examined in detail. H. H. Ho.

1230. *The Constitution and Fundamental Properties of Solids and Liquids. II. Liquids.* **I. Langmuir.** (Am. Chem. Soc., J. 39. pp. 1848–1906, Sept., 1917. Chem. News, 116. pp. 183–185, Oct. 12, 252–256, Nov. 23, and pp. 261–263, Nov. 30, 1917.)—In the first part of the author's memoir [Abs. 171 (1917) and Chem. News, 116. pp. 169–172, Oct. 5] reasons were given for believing that all forces acting between atoms (or group molecules) in solid bodies are fundamentally similar in character and are of the nature of so-called chemical forces. The author now discusses the constitution and properties of liquids from the same standpoint, prefacing this discussion, however, by a discussion of "physical" and "chemical" forces, from which the conclusion is drawn that *all* the interatomic and intermolecular forces involved in the structure of matter are chemical forces. These forces, the author recognises, are of two kinds, those represented by primary and those represented by secondary valence, the distinctions between these two being in general well defined. If the forces holding solid bodies together are chemical forces (as the author has argued in Part I), represented by primary and secondary valence, then there is every reason for believing that chemical forces are also responsible for holding the atoms and group-molecules of liquids together. The mobility of a liquid is due to a shifting of the relative positions of atoms which are all chemically combined with each other. This mobility of the atoms within the chemical molecule is nothing more than the familiar phenomenon of tautomerism. From the experiments of Devaux, Rayleigh, Marcellin, and Pockels, which have shown that small amounts of certain oils on the surface of water have no effect on the surface tension of water until the amount of oil per unit area is increased beyond a certain sharp limit, the conclusion is drawn that the amount of oil necessary to affect the surface tension corresponds with a layer one molecule deep. On the basis of this, the author assumes that the force which causes the spreading of the oil is due to an attraction between a *portion* of the oil molecule (the COOH group of oleic acid, for example) and water, while the remainder is more attracted to other oil molecules than to the water. Herein the author finds the explanation of the spreading of oil on a water surface. In the absence of "active" groups (which are attracted to water molecules) no spreading occurs. This is seen, for example, in the case of pure hydrocarbon oils. The view put forward by the author therefore leads to the conclusion that the molecules are lightly packed side by side, and are more or less erect upon the surface. Determinations of the shapes of group molecules have already been contributed by the author [Abs. 726 (1917)]. The author has also determined the forces required to suppress surface films in the case of films of lauric, myriotic, palmitic, stearic, arachidic, and cerotic acids; of cetyl, ceryl, and myricyl alcohols; of tristearin, cetyl palmitate, amyl stearate, and ethyl palmitate; and of triolein, trielaidin, ethyl oleate, linseed oil, castor oil and other oils. The experimental results obtained afford the strongest confirmation of the theory that the spreading of films on surfaces is determined by the shapes of molecules and the relative activities of the different portions of the molecules. The author also applies his theory to the explanation of the values of surface tension obtained by different workers. With regard to adsorption phenomena in general, the author also holds that the principles already outlined are applicable. A. F.

1231. *Viscosity of very Viscous Media.* **S. E. Sheppard.** (Eastman Kodak Co.'s Research Lab., Abridged Sci. Publ. 2. No. 40. pp. 105–110, 1915–1916.)—This absolute determination was carried out by allowing steel balls, $\frac{1}{4}$, $\frac{1}{6}$, and $\frac{1}{8}$ in. in diam., to fall through a very viscous solution of nitrocellulose of specific gravity 1·008; Stokes' law of terminal velocity being used with corrections for finite diam. and height of containing vessel. The final mean values are: 889·7 $cm.^{-1}$ gm. $sec.^{-1}$ absolute at 20° C., or $8{\cdot}9 \times 10^4$ relative to water at 20° C. [See Abs. 265 (1912).] E. H. B.

1232. *Standard Substances for the Calibration of Viscometers.* **E. C. Bingham** and **R. F. Jackson.** (Bureau of Standards, Bull. 14. pp. 59–86 [Sci. Papers, No. 298], 1917.)—As a result of the investigation of various liquids for use as standards in the calibration of viscometers of several forms, it is concluded that mixtures of 20, 40, and 60 % ethyl alcohol in water (by weight), and solutions of 20, 40, and 60 % of surcrose are the most suitable. Tabulated values of the viscosities and fluidities of these liquids from 0° to 100° C. at intervals of 10 deg. C. are given. From the curves of fluidities given it is considered that, owing to their simple shapes it would be better to use the fluidity rather than the viscosity, its reciprocal, when making calculations. L. H. W.

1233. *On Periodic Convection Currents in the Atmosphere.* **H. Jeffreys.** (Phil. Mag. 34. pp. 112–128, Aug., 1917.)—This is a mathematical analysis of the motion of an incompressible fluid under gravity which is subjected to a periodic supply of heat. Complete solutions are obtained in two special cases of distribution of heat supply.

An approximate application of the analysis is made to the case of the atmosphere when subjected to diurnal and seasonal variations of temperature, in order to ascertain whether the neglect of terms depending on the velocity is justified when forming the equation of vertical motion. This is equivalent to an examination of the hypothesis that the pressure at the bottom of the atmosphere is treated as the hydrostatic pressure due to the weight of the superincumbent air. The conclusions are that the hypothesis is justified both for seasonal and diurnal variations in the case of continental land masses, but that the neglect of the vertical velocity is not justified in the case of small islands. It is also shown that diurnal convective motion cannot penetrate far into the interior of a large continent. R. C.

1234. *Relative Humidities and Vapour Pressures over the United States.* **P. C. Day.** (Monthly Weather Rev., Supplement No. 6. [61 pp.], 1917.)—This paper consists to a large extent of tables, charts, and diagrams by means of which the various phases of the existence of water-vapour in the atmosphere may be studied; a discussion of data from recording hair hygrometers is included. L. H. W.

1235. *The Horizontal Oscillation of the Free Atmosphere up to 10 km. at Batavia.* **W. van Bemmelen** and **J. Boerema.** (K. Akad. Amsterdam, Proc. 20. pp. 119–135, 1917.)—The data used for the determination of the diurnal variation of wind velocity at different heights is taken from pilot balloon ascents made both by day and by night during the 7 months May to Nov. at Batavia when the prevailing winds are easterly. A variation comprising 24-hour and 12-hour terms has been assumed and the values of the harmonic constants were determined by the method of least squares from the difference in velocity found between pairs of consecutive ascents. By this means it is hoped that non-periodic variations have been largely eliminated. The E.-W. and N.-S. components have been dealt with separately. The general coast-line runs E.-W. at Batavia and, as would be expected, the influence of land- and sea-breezes is distinctly felt in the N.-S. component at the lower levels. The mixing of upper and lower wind currents by convection (Espy-Köppen effect) also makes its influence felt. It is found that these influences may be neglected above 4 km. and the present discussion is mainly confined to the levels above this height, while the lower layers will be dealt with separately in a later paper. A series of observations is at present in progress from a small island in the Java Sea where the conditions approximate more closely to those over the open ocean. The results from the present series for levels above 4 km. show (1) that the amplitude of the 24-hour variation is small for both N. and E. components; (2) that the 12-hour term of the N.-S. component is also small, though more definite than the 24-hour term; and (3) that the amplitude for the 12-hour term of the E.-W. component is much larger and increases from about 28 cm./sec. at the surface to 54 at 4 km. It then decreases to 22 cm./sec. at 7 km. and increases again to 38 at 10 km. The phase angle diminishes up to 4 km. and above this remains almost constant at 150° to 6 km. The observations are not at present numerous enough to allow of any very accurate determination of the changes of phase above this height. In the lower layers the variations seem to be in agreement with the theoretical results which Gold has deduced from the pressure variation. J. S. Di.

1236. *Hail in the United States.* **A. J. Henry.** (Monthly Weather Rev. 45. pp. 94–99, March, 1917.)—The paper contains a considerable amount of tabulated data relating to hail storms and snow cover and evaporation, and should be consulted in its entirety. The following is taken from the author's brief summary of conclusions:—"It seems well established that the density of fresh snow is least in mid-winter and greatest in late spring and that, in general, the density increases with the temperature, but the tendency for precipitation to occur in the form of rain or sleet with temperatures above freezing adds to the uncertainty of density measurements when the air temperature is above freezing. It is believed that the error in density measurements with surface temperatures above 32° F. is greater and more frequent than is generally supposed. The density of a snow cover, other circumstances as to weather being equal, is fairly uniform, as shown by the intensive snow surveys made in the West within the last few years. It seems well established, however, that, due to basic climatic differences, higher densities are to be expected in the North-eastern States than in the semi-arid States of the West and South-west." L. H. W.

1237. *Volcanic Exhalations.* **A. Brun.** (Archives des Sciences, 44. pp. 5–18, July 15, 1917.)—The anhydrous nature of volcanic exhalations has been established; and this paper deals with other elements present, with the object of throwing light upon the seat of volcanic activity. The author has consequently made a study of the salts and fumarole products emanating from Vesuvius, Etna, Kilauea, etc., over a period of a century, and also of volcanic fragments from the Pacific depths as well as of a large variety of lavas of different origin. The method of investigation employed was to study the salt or rock spectroscopically by means of the very hot flame of the oxy-hydrogen or oxy-acetylene blowpipe. The elements were then recognised by their characteristic lines, and afterwards separated by ordinary chemical procedure. The present paper deals with boron, lithium, and thallium, the greater part being devoted to the latter element. The presence of this element had previously been regarded as accidental, and the author now shows it to be a serious constituent of volcanic exhalations. A section is devoted to the distribution of Tl among volcanic deposits. Soluble thallium chloride has been found impregnating chloro-fluor ammoniacal salts at Vesuvius and Chinyero; also an insoluble compound penetrating the red and violet scoria altered more or less by fumarole emanations at Spagnuolo, Vesuvius, and Etna, while sulphides of thallium and arsenic have been found associated in red crusts of realgar and orpiment at Vesuvius. Thallium in ammonium salts is exhaustively described, a detailed account of its chemical separation and isolation being included. Another detailed account is given of the thallium in red scoria and in the realgar sand of Vesuvius. The general conclusions drawn are that B, Li, and Tl belong to the paroxysmal volcanic exhalation in the same way as those elements which have been already established. The existence of these elements in eruptive magmas presents a certain generality. Thallium, like lead, may be of assistance in the study of the volcanic depths, as the presence of these elements should be considered as a confirmation of physico-astronomical data relating to the average density of the globe. H. H. Ho.

1238. *Thermal Gradient of Kilauea Lava Lake.* **T. A. Jaggar, Jr.** (Washington Acad. Sci., J. 7. pp. 397–405, July 19, 1917.)—Experimental temperature measurement with Seger cones in steel pipes thrust into the lava and flaming cones in 1917, when the lava pool of Halemaumau became accessible, yielded results of increasing accuracy as the method was improved and the sources of error or failure were eliminated. Excessive oxidation of the combustible constituents S, CO, and H on contact with air makes the confined and continuously flaring grottoes hotter than the central fountains. The temperatures vary, but 1180° C. for the fountains and 1180° for the open grottoes are approaching the maximum. Measurements in the past have been made with Féry and Holborn-Kurlbaum optical pyrometers and with the Pt-Rh thermo-element, and have shown that the surface temperatures of the Kilauea magma range from 940° to 1185°. Temperature measurement below the surface, or in the gas-filled chambers and orifices of flaming blowing-cones on the benches has not been attempted previously. The thermal gradient of the liquid lake to its bottom is not the gradient of the lava column, which latter could only be determined by profound soundings along with temperature measurements in the conduits and sinkholes. The liquid lake is a shallow pool of lava continually engulfing vesicular crusts, which must be full of air, and which do not melt at once, as the upper temperatures are not those of superfusion. The determination of the gradient of the pool is of interest to show (1) whether reaction between gases rising from the bottom produces increased heat upward, or (2) whether surface radiation and expansion of the gases in vesicles make a graded cooling effect upward, or (3) whether a combination of these two processes, and also surface oxidation of the gases, bottom oxidation due to foundered crusts containing air, or bottom radiation, in some way complicate the curve. That it is a smooth curve seems unquestionable. Condition (3) seems nearest the measured gradient. The various measurements are described in detail accompanied by tables of data. H. H. Ho.

1239. *Statistics of Italian Earthquakes.* **A. Cavasino.** (Soc. Sismol. Ital. Bull. 20. pp. 9–81, 1916. Nature, 99. p. 392, July 12, 1917. Abstract.)—The statistics of Italian earthquakes during the twenty years 1891–1910 are examined. The total number of earthquakes recorded is 5922, giving an average annual number of 296. The Calabrian earthquake of 1905 was followed by a train of 396 after-shocks, the Messina earthquake of 1908 by 1227. It is generally supposed that the greater frequency of earthquakes at night is apparent and due to the quiet of the midnight hours. The author shows that this is not the case for Italian earthquakes by considering only shocks of such intensity that they could not escape notice at any hour of the day. Of these, 865 occurred during the twelve night-hours, and 688 during the day-hours.

1240. 150-*Foot Tower Telescope of Mount Wilson Solar Observatory.* **A. van Maanen.** (Roy. Astron. Soc., Canada, J. 11. pp. 228–231, July–Aug., 1917.)—A short *résumé* is given of the work being carried on with the new 150-ft. tower telescope at Mount Wilson, which has now been in operation for five years. To eliminate vibration from wind the tower is of double skeleton construction, each member being supported on separate concrete piers. The outer tower carries the revolving dome, while the inner one carries the cœlostat and mounting for the objective. The lens is 12 in. in diameter, focal length 150 ft., giving a solar image over 16 in. in diam. This is projected on the slit of a spectrograph of 75 ft. focal length in an underground pit for constant temperature, and when this latter is used with the third-order grating spectrum the visible spectrum from λ3900 to λ7000 is about 50 ft. long. Provision is also made for using image lenses and spectrograph lenses of different focal lengths. All the necessary adjustments may be made by electrical means from the observer's position near the spectrograph head. During the past five years the investigations undertaken with this powerful instrument have included work on "the Flash spectrum without eclipse"; "Solar Rotation"; "Sun-spot spectrum"; "Sun-spot magnetic polarities"; "General magnetic field of the sun": details of many of these have already been published in the series of "Contributions" issued from the observatory, and a short summary of them is included in the note. C. P. B.

1241. *Moon's Place at Solar Eclipse of* 1918 *June* 8. **E. W. Brown.** (Astron. J. 30. 176–178, June 29, 1917.)—In the course of trial computations from the new Lunar Tables, the differences of the new values from the published ephemerides became available, and these are given for the epoch of the solar ellipse of 1918 June 8, which will be visible in America. The corrections are tabulated from 1918 May 25 to 1918 June 23, and are for longitude, latitude, and parallax. C. P. B.

1242. *Sun-spots in High Southern Latitudes.* **[Mrs.] W. Maunder.** (Roy. Astron. Soc., M.N. 77. pp. 621–628, June, 1917.)—Certain small markings, defined as "flecks," have been detected on solar photographs taken at the Cape Observatory, and examined in conjunction with others taken at the Greenwich Observatory. When they occur in the ordinary spot zones they may be treated as being faint or short-lived spots, but they have also been found in solar latitudes far beyond the usual zones of spot activity. Details are given of the heliographic positions of a number of these markings on photographs obtained during March, 1916. The latitudes vary from —62·6° to —74·6°. C. P. B.

1243. *Search for Einstein Relativity Effect in the Sun.* **C. E. St. John.** (Nat. Acad. Sci., Proc. 3. pp. 450–452, July, 1917.)—An investigation has been made of the behaviour of the component lines of the prominent nitrogen (cyanogen) bands at λ3883, when observed at the centre and limb of the sun, with the object of detecting displacements of the type predicted by the relativity effect of Einstein. The results are grouped according to line intensity, and given in terms of the difference in wave-length between the solar lines and standard iron lines in a comparison spectrum of the iron arc. The general conclusion is that within the limits of error the measurements show no evidence of an effect of the order deduced from the equivalence relativity principle. Two other series of observations at Mount Wilson are at variance with the relativity principle: (*a*) the equal wave-lengths of the H and K lines of calcium in the arc and at the sun's limb; (*b*) a centre arc displacement of 0·004 Å. at λ6300 for iron lines instead of 0·013 Å. as required by the theory. C. P. B.

1244. *Position of Saturn's Equator.* **G. Struve.** (Astron. Nachr. No. 4880. Observatory, No. 516. p. 312, Aug., 1917. Abstract.)—Based on a long series of observations extending over nearly 80 years, from the early work by H. Struve at Pulkova to the more recent determinations by Frederick and Hammond at Washington during 1903–1908, by Barnard at Yerkes during 1910–1914, and by H. Struve at Babelsburg during 1916. During this period the pole of the orbit of Rhea has completed almost a revolution, and those of the other satellites several revolutions, so that the position of Saturn's equator can be derived with accuracy from the observations not only of Dione and Tethys, but also from those of Rhea. The results are tabulated as given from the separate satellites, and also the final result compared with older determinations. C. P. B.

1245. *Rotation of the Moon.* **A. Jõnsson.** (Lund Observat., Meddelanden, Ser. 2. No. 15. Nature, 99. pp. 494–495, Aug. 16, 1917. Abstract.)—Following a summary of the progress of our knowledge of the moon's rotation, mention is made of the large range in the determinations of the coefficient of the physical libration; from 19·1′ obtained by Puiseux (by measurements of 40 photographs covering a period of 15 years) to other records from 5·7′ to 1·0′. The question is then developed analytically on the lines of the methods introduced by Zinner and Charlier, and a result obtained indicating that the Puiseux coefficient is too high. C. P. B.

1246. *Principal Axes of Stellar Motion.* **H. Raymond.** (Nat. Acad. Sci., Proc. 3. pp. 485–490, July, 1917. Astron. J. 30. pp. 191–200, Sept. 28, 1917.)—An analysis has been made of 5948 proper-motions less than 30″ per century from Boss's Preliminary General Catalogue, and a method developed for determining therefrom the principal momental axes of the velocity-figure. All the groups show unequal motion in three principal directions, the axis of preference lying near the plane of the Galaxy not far from its intersection with the equator, while the axis of avoidance is nearly perpendicular to the Galaxy. A separation of the poles of preference into two groups is noted, corresponding to early and late types. With advance of type there is an advance of stellar compared with solar motion. C. P. B.

1247. *Systematic Motions of Stars.* **F. W. Dyson** and **W. G. Thackeray.** (Roy. Astron. Soc., M.N. 77. pp. 581–596, June, 1917.)—A discussion is given of the systematic motions of stars in the zone between Decl. + 24° and Decl. + 32°, determined from the proper motions of about 12,000 stars in the Greenwich Catalogue for 1910. The plotted results indicate clearly the want of symmetry in the direction of the proper motions due to star-streaming. The existence of two star-streams is considered quite definite, but no satisfactory evidence of Stream III was indicated. The latter portion of the paper deals with the distribution of the proper motions in relation to the Milky Way. C. P. B.

1248. *Notes on Tourbillon Cosmogonie.* **E. Belot.** (Comptes Rendus, 164. pp. 997–1000, June 25, 1917.)—Further notes are given in elaboration of the view that planetary distances and many of their physical features are to be explained as the result of tourbillon movements in the original nebulous magma. The results are tabulated for Mars, the Earth, Venus, and the Moon. C. P. B.

1249. *Current of Stars in Sagittarius.* **J. C. Solá.** (Comptes Rendus, 165. pp. 149–150, July 23, 1917.)—Comparison of photographs taken on 1912 June 17 and 1917 June 12 in a stereogoniometer, indicates the presence of a common motion of many of the stars in the direction of mean position-angle 298°. C. P. B.

1250. *Pulsation Theory of Cepheid Variables.* **A. S. Eddington.** (Observatory, No. 516. pp. 290–293, Aug., 1917.)—Shapley has given evidence for concluding that the Cepheid variables are not binary stars, although they show periodic changes of radial velocity, and has suggested that the variations may be due to pulsations of the material of the star [Abs. 288 (1915)]. This idea is examined from the conservation-of-energy standpoint. In the case of a typical Cepheid, with a semi-amplitude of 1,000,000 km., and period of 6 days, assuming the motion to be simple harmonic, the max. acceleration would be 14· cm./sec.^{2} This is only a small fraction of the probable value of gravity on such a star, which may, however, be modified by the nature of electrical forces and radiation-pressure. C. P. B.

1251. *Spectroscopic Binary Orbits.* **R. K. Young.** (Roy. Astron. Soc. Canada, J. 11. pp. 213–216, July–Aug., 1917.)—Details are given of the orbits of three binary systems, 40 Aurigæ, π Arietis, and Boss 5996, derived from one-prism spectrograms taken at the Dominion Observatory, Ottawa. The periods determined are 28·28, 3·854 and 3·2195 days respectively. Curves are given showing the derived radial velocities throughout the periods. C. P. B.

1252. *Stellar Radial Velocities.* **R. K. Young.** (Roy. Astron. Soc. Canada, J. 11. pp. 217–222, July–Aug., 1917.)—Results are given of the determined radial velocities of stars obtained during preliminary work on binary orbits. The stars included are γ Pegasi (+ 5·8 km.), T Persei (+ 1·6 to + 7·8 km.), δ Geminorum (− 6·2 to + 17·4 km.), β Canis Majoris (+ 19·9 to + 39·2 km.), α Cancri (+ 0·8 to − 38·0 km.), 22 Bootis (− 28·2 to − 32·9 km.), α_2 Libræ (− 47·1 to − 46·2 km.), BD 56·1798° (− 30·0 to + 8·8 km.), ζ Ophiuchi (− 11·3 to − 18·6 km.), 102 Herculis (− 16·2 to − 27·0 km.) and Boss 4842 (− 22·8 to − 29·2 km.). C. P. B.

1253. *Relations of Spiral Nebulæ to the Milky Way.* **R. F. Sanford.** (Lick Observat., Bull. 9. [No. 297] pp. 80–91, 1917.)—An extended study of the distribution of spiral nebulæ, supplemented by long exposures with the Crossley reflector for special regions, leads to the view that an arbitrary and general distribution of these objects is harmonised with the system that presents itself to observation, by means of the hypothesis of an obstructing medium irregularly distributed throughout the Galaxy. The solar system is assumed to lie to the South of the median plane of the Galaxy, and near its short axis, but within the realm of the obstructing medium. C. P. B.

1254. *Determination of Distances of Globular Star-clusters.* **H. Shapley.** (Nat. Acad. Sci., Proc. 3. pp. 479–484, July, 1917.)—Further investigation of the Cepheid variables in the globular star-cluster M_3 shows that the median magnitude (mean of maximum and minimum) is remarkably near a constant value, about 15·50; for all the component stars found to be variable. Similar constancy is found in other clusters having Cepheid variables, but the median magnitude is slightly different in different clusters. If it is assumed that for these objects the absolute median magnitude has a definite value, identical for all clusters, but modified by distance, a method is available for determining the distances. The stars possess identical spectra and colour variations. A preliminary value of this suggested absolute median magnitude indicates that with one or two exceptions no globular cluster is nearer than thirty thousand light-years ($\pi = 0·00012''$). C. P. B.

1255. *Observations of S.X. Aurigæ.* **C. Martin** and **H. C. Plummer.** (Roy. Astron. Soc., M.N. 77. pp. 627–632, June, 1917.)—Certain anomalies are presented in the period of this variable, which has a photographic range of magnitude from 7·8 to 8·6, and a visual range, according to Erebus, from 8·4 to 9·8, indicating a negative colour-index of about half a magnitude. This suggests that the type is B-A, and that the star is possibly of the β Lyræ type. Tables are given showing the results of observations of the variable from 1914 Nov. 10 to 1917 Mar. 12, the epochs being based on an assumed period of 1·58284 days. A curve is reproduced showing the plotted results, and a smoothed curve from an assumed formula giving a symmetrical curve.
C. P. B.

1256. *Proper-motion of Andromeda Nebula* (*M* 31). **E. E. Barnard.** (Astron. J. 30. pp. 175–176, June 29, 1917.)—Micrometric measures of the nucleus of the Andromeda nebula ranging from 1898 to 1916 give no indication of visual displacement of the nebula during these 18 years, and the individual measures show that the parallax is beyond the reach of ordinary micrometer work. The nucleus is about 2″ or 3″ diam., but is so strongly condensed that under good conditions it can be bisected with almost the same accuracy as the comparison stars, which are assumed to be unconnected with the nebula. A comparison is made with a set of old measures by Lamont at Munich in 1836, which show that no considerable motion has occurred in the past 80 years. C. P. B.

1257. *Two New Variable Stars.* **E. E. Barnard.** (Astron. J. 30. p. 176, June 29, 1917.)—Two new variables have been detected on photographs taken with the Bruce telescopes, and have been verified as not hitherto recorded on the Harvard photograph. One is in the position RA = 18h. 25m. 14·8s.; Decl. = + 18° 21·6′; it varies through several magnitudes, with a maximum near 12. The other is in position RA = 18h. 25m. 11·6s.; Decl. = + 9° 46·7′; this on 1917 June 2 was about 14·7 magnitude and perhaps gets to a maximum of 12. Both places are for epoch 1900·0. C. P. B.

1258. *Radiative Equilibrium of the Stars.* **A. S. Eddington.** (Roy. Astron. Soc., M.N. 77. pp. 596–612, June, 1917.)—Further calculations have been made on the assumption that the average molecular weight of the material of a star is 2, instead of 54 as taken in a former paper. From this new standpoint it is supposed that the atoms are highly ionised, so that most or all of the electrons outside the nucleus are broken away and move as independent particles, and there will be a different result in that the influence of the star's mass on the temperature is increased. C. P. B.

1259. *Southern Star Magnitude Distribution.* **R. A. Sampson.** (Roy. Astron. Soc., M.N. 77. pp. 613–621, June, 1917.)—A decided contradiction having appeared in the value for the galactic condensation as determined by Seares at Mount Wilson, and Chapman and Melotte at Greenwich, an examination is made of the data supplied by the Perth Astrographic Zone, — 32° South Declination. This leads to the conclusion that it is difficult to accept the Chapman and Melotte averages as representing the actual mean distribution over the whole sky. An interesting analysis is also given of the counts for zones — 38°, — 39°, and — 40°, taken at Perth, and measured at Edinburgh. The plotted curves from these results show clearly the "obscured patch" first detected by H. H. Turner; also the dark rift in the middle of the galactic condensation about 16h. C. P. B.

1260. *Observations of R.T. Cygni*, 1912–17. **A. N. Brown.** (Roy. Astron. Soc., M.N. 77. pp. 550–555, May, 1917.)—Details are given of the observed magnitude of this long-period variable from 1912 Jan. 26 to 1917 April 15, with an additional table showing the maxima and minima from 1908 to 1917. C. P. B.

1261. *Thermal Diffusion in Stars.* **S. Chapman.** (Roy. Astron. Soc., M.N. 77. pp. 539–540, May, 1917.)—It has been shown that a temperature gradient in a mixture of two gases will in general produce diffusion, a steady state being possible only when this tendency has become neutralised by its own action in producing a concentration gradient [Abs. 147, 518 (1917)]. As large temperature gradients are known to exist in the stars, the inquiry has been extended to include the cases considered possible. Since the temperature of a star diminishes from centre to surface, the tendency is for the heavier molecules to be raised to the higher levels. In the case of the sun the observational data available agree in showing that heavy elements are near the surface, but as powerful convection is present in the solar atmosphere it seems most likely that the presence of elements of widely different weights is due to this cause. C. P. B.

1262. *Convection and Diffusion within Giant Stars.* **S. Chapman.** (Roy. Astron. Soc., M.N. 77. pp. 540–548, May, 1917.)—The question of the action of thermal diffusion is further considered with respect to its effect in giant stars of low density, calculations being made to determine the amount of stratification, or separation of the different constituents of the star into concentric layers, which might be expected if diffusion be supposed to act without any mixing influence. These will need to be modified if it is shown that the interior of a star is not in the physical condition assumed, and Jeans has recently suggested [Bakerian Lecture, 1917] that at the high temperatures in the interior all molecules may become split up into their component electrons, so that differences of molecular weight or constitution are eliminated. C. P. B.

LIGHT.

1263. *Compensating Filter for Spectroscopy.* **M. B. Hodgson** and **R. B. Wilsey.** (Eastman Kodak Co.'s Research Lab., Abridged Sci. Publ. 2. No. 42. pp. 117–120, 1915–1916.)—Luckiesh has described a method which he has employed with success in obtaining uniform photographic intensity throughout the spectrum, using a light source yielding a continuous spectrum [Abs. 1080 (1916)]. Morris-Airey suggested the method. The spectrum of the light source used is first photographed in the usual manner upon the particular brand of panchromatic plates selected, exposing through the glass. This negative is then developed, fixed and dried, and further exposures are made using it as a filter in contact with the emulsion of the print plate. The theory is that those portions of the spectrum which are most actinic will be restrained, in proper ratio, by the densities they have impressed upon the initial plate. The photographic laws of the process have not been discussed hitherto, and a brief treatment is now given. It is shown that: (1) The filter and print plate must be made on plates of the same emulsion. (2) The filter must be neutral in colour. (3) All densities in the filter must lie on the straight-line portion of the characteristic curve. (4) The straight-line portion of this characteristic curve must have a slope of 1 (*i.e.*, $\gamma\lambda = 1$) for all wave-lengths. The authors have found that by using this method they are able to obtain satisfactory spectrograms for qualitative or quantitative analysis of absorption spectra. To secure a silver deposit of neutral absorption the authors have used an "elon" developer. Ferrous oxalate is even better in securing approximately non-selective densities. A: W.

1264. *Quantitative Light-filter for the Ultra-violet part of the Spectrum.* **N. P. Peskov.** (J. Phys. Chem. 21. pp. 382–401, May, 1917.)—The author summarises his results as follows:—(1) Through qualitative study of spectrodiagrams a light-filter was found which absorbs the region of spectrum between 500 and 300 $\mu\mu$. It consists of a mixture of gaseous Cl and Br. (2) Henri's photographic method for determination of the coefficient of absorption in the invisible part of the spectrum was developed and somewhat improved. (3) By means of Henri's method, absorption coefficients of gaseous Cl and Br were determined for 48 lines of the quartz lamp spectrum. (4) Mathematical treatment of the process of light absorption by mixtures of several components is given. By means of formulæ deduced, the question whether a mixture of Cl and Br follows Beer's law was investigated experimentally. The investigation gave positive results. (5) The light-filter found was subjected to quantitative study. Mixtures of Cl and Br were found which could be used for filtering off certain previously calculated regions of spectrum. The region of transmitted light could be made as narrow as 250–240 $\mu\mu$. L. H. W.

1265. *The Modern Range-finder.* **F. J. Cheshire.** (Nature, 100. pp. 14–15, Sept. 6, 1917. Review by C. V. Boys.)—The War Office has published the pamphlet here reviewed.

In principle the problem of range-finding may appear simple. The observer has to utilise the angle of convergence upon a distant object of the widely spaced eyes of the range-finder in order to find the distance of the object. But the real difficulty is to make an instrument which shall be portable, handy, and quick in use, and also shall attain the ultimate possible limit of accuracy. The instruments now turned out daily attain a perfection exceeding the utmost an inventor might hope for. Some form of reflecting device is needed at each end to bring the two sets of optical beams together into a single eyepiece. Simple reflectors at the ends would double any angular displacement due to bending of structure or to differential heating. Double-reflection prisms, though they may be tilted without altering the apparent direction of the object, would have to be of inconvenient size for such oblique reflection. Pentagonal prisms are therefore used; they require to have their reflecting faces silvered, as they are within the critical angle. The prismatic devices must be capable of bringing the two beams into perfect alignment when the object is at very great distance, and the line of demarcation between the fields must be sharp throughout—this is essential to accuracy. The fields may both appear erect, or one may be inverted laterally or vertically. The alignment is affected by convergence of the beams, and the optical device by which the alignment is corrected, such as a sliding prism, is connected with a scale from which the distance may be read directly. In the Barr and Stroud range-finder, which is more particularly described and illustrated in the pamphlet, this scale is seen by the other eye through a separate eyepiece. In the essential sharpness of the line of demarcation the Barr and Stroud instrument is superior to two German forms. In this range-finder the two beams are thrown up at an angle of 60° for the greater convenience of the observer. In one form of range-finder made by Zeiss the telescopic magnification of the two beams is different, so that the images seen in juxtaposition are of different dimensions. In that case there is no necessity to employ sliding prisms and scale, as the part of the field where the coincidence occurs depends upon the distance of the object, and thus a scale of distance at the focus of the eyepiece is all that is needed.

Of all methods of using the angle of parallax to find the distance, the most attractive is one proposed by a workman in the Zeiss works and shown at the Paris Exhibition of 1900. The reviewer remarks that some discussion of this type of range-finder in the War Office pamphlet would have been very valuable. The right and left beams are received by the right and left eyes respectively of an observer, and owing to the distance of the two beams entering the instrument a super-steroscopic view of the object is seen. At the same time each eye sees in the field of view a scale of distance, but the two scales are differently ruled in such manner that the eyes combine them stereoscopically and the scale of distance appears projected away into space. For the use of aircraft this method offers great advantages on account of its speed, and even if it were less accurate than other methods this is not of consequence where the range is changing rapidly. The number of the German patent is 82,571, the date July 1897. (See E. Abbe's Collected Papers, vol. ii, published by G. Fischer, 1906.)

Regarding accuracy, the figures quoted for a Barr and Stroud range-finder are important and surprising. The base of the instrument was 8 yards, the diam. of the object glasses is not stated. The mean error of settings by a skilled observer was about one-fifth of a second of arc. The defining power of a telescope as measured by diam. of the star image is about 4·5 secs. of arc divided by the aperture in inches. If, as is likely, the aperture is about 2 in., the defining power would be about 2·2, so that the aligning power is more than ten times the possible separating power. Also, on multiplying by the magnifying power, it appears that the aligning power of the unaided eye is about 8 secs. of arc, which is still more surprising when it is remembered that the separating power of the eye is insufficient to divide 60″. It would be interesting to inquire into the aiming power of a good billiard-player.

There is much more in the pamphlet that is of interest. [See also Abs. 50 (1916).] A. E.

1266. *Optical Constants of the Binary Alloys of Silver with Copper and Platinum.* **L. K. Oppitz.** (Phys. Rev. 10. pp. 156–165, Aug., 1917.)—The object of the investigation here described was the study of the optical constants of two complete series of binary alloys, Ag-Cu and Ag-Pt. Silver and copper form a series of alloys in which there are two limited series of solid solutions, separated by a gap. This gap consists of a series of eutectiferous alloys, extending from 8·5 % of copper-concentration to 96 %, the eutectic mixture being found at 40 % Cu concentration. Platinum and silver similarly form two series of solid solutions separated by a gap extending from approximately 84·8 % to 88·5 % of Pt concentration, and in which is found a heterogeneous mixture of Ag and Pt. The method of polishing the mirrors was approximately that of Drude, and Drude's formulæ were employed in the calculation of the optical constants. The results obtained, which are represented graphically and also tabulated, show that near the eutectic point the index of refraction is lower than that of any other member of the Ag-Cu series, except that of pure Ag, while the absorptive index is a relative maximum for the same concentration. The indices of refraction of the alloys at the saturation points in the two regions of solid solutions for Ag-Cu are higher than that of the pure metal near these points. From the eutectic point of the silver-copper series, there is a marked increase in the index of refraction in either direction until saturated solid solutions are formed. The absorptive index shows a behaviour which is approximately the inverse of that shown by the index of refraction. The reflecting power of a metal of relatively low reflecting power is in general improved by mixing this metal with one of relatively higher reflecting power. For Pt-Ag alloys the concentration-refractive-index curve shows an unmistakable increase toward pure Pt. The concentration-absorptive-index curve indicates a very sudden drop from pure Ag to the next member of the series, after which the decrease is very gradual. The absorptive index of pure Pt is slightly lower than that of the solid solutions of Ag in Pt. In general, whenever solid solutions are formed, an increasing index of refraction indicates a decreasing index of absorption. This is borne out both by the Ag-Cu and Ag-Pt series. [See also Abs. 819 (1910).] A. W.

1267. *Optical Properties of Light-filters.* **C. E. K. Mees.** (Eastman Kodak Co.'s Research Lab., Abridged Sci. Publ. 2. No. 41. pp. 111–116, 1915–1916.)—The optical effects produced by the use of colour filters may be divided into two classes. The first class includes those resulting from the use of a theoretically perfect filter; the second, those which result from imperfections occurring in the filters—that is, from departures from the conditions of plane parallelism in the faces and of equality in thickness between the three filters of a set. The effect of a plane-parallel filter on the aberrations of a lens system is considered first. Suppose that a plane-parallel piece of glass is placed in front of a lens, then it will produce upon the oblique rays a displacement compared with the axial beam which will result in two effects: (*a*) it will give rise to a species of spherical aberration all over the field, causing the marginal rays of each image-forming pencil to focus at a greater distance from the lens than its central ray; and (*b*) on account of the tendency of a small oblique pencil to foreshorten abnormally in the object plane, the image plane will be curved backward. These displacements are greatest when the obliquity of the rays is greatest; they also depend upon the thickness of the filters. The spherical aberration and curvature of field produced by interposing in front of the objective a filter 15 mm. thick and of index of refraction 1·55 is worked out, given a process lens working at F/6·3, of 16 in. focal length, taking a picture 10 × 12 in. and forming an image one-half the size of the object.

The effect of a set of perfect filters is next dealt with. If for the three colours we use filters of the same thickness, then we shall obtain a difference in the size of the images produced owing to differences in the refractive index of the glass for different colours of light; that is to say, the effective thickness will be altered by the dispersion of the glass. The amount of this can be calculated for a given glass, knowing its refractive index and dispersion. For a typical glass used for filters, and taking a filter thickness of 15 mm., the difference in refractive index between the red and the green was 0·068 and between the green and the blue 0·0159, which gave an effective difference of path between red and green of 0·048 mm. and between red and blue of 0·142 mm. Such a filter will not be used with a smaller optical path than 50 cm., and in general if used in front of the lens, the distance from the object plane to the nodal plane of the lens will be 1 m. or more and the effect will therefore produce a difference in size between the red and blue images of the order of one part in 5000, an amount which is much smaller than the resolving power of the half-tone screen used in photo-engraving and, in practice, is indistinguishable. The effects upon the definition and size of image that are introduced by the use of filters which are imperfect, either in plane parallelism of surface or in equality of thickness, in a set of filters are naturally more complicated than those which result from the use of perfect filters. Since the errors of surface may be of any type—wavy, spherical, wedged, or cylindrical—the investigation of the effects produced can only be performed experimentally. When a proper experimental method had been worked out it was found that some filters which gave quite perfect images with lenses appeared poor in an interference test, while other glasses which showed up much better in the interference test were useless for the purpose of light filters upon long-focus lenses. This being so, it was found necessary to test the filter by the observation of its effect upon a lens image. The differences in the size of the images produced by a set of three colour-filters which differ slightly in thickness and also in focal length due to cylindrical or spherical curvature of the faces, might be thought to be subject to accurate calculation, but the effects are so complicated that it was found desirable to design an instrument for directly measuring these differences. An instrument was therefore constructed in which a lens of about 25 cm. focal length formed two images about 20 cm. apart of two cross-hairs, the distance between the images being measured by means of microscopes mounted on carriages actuated by micrometer screws. The various filters could therefore be placed over the lens, and the effect of the filter upon the size of image could be directly determined and compared with the amount calculated from the focal length and the thickness. The results obtained with this apparatus are given. It is further noted that two filters may be of the same power, but if in one filter the front surface is curved and in the other the back, this will produce a shift in the nodal point of the filter of about its own thickness, and a difference of size of image. The effect, however, is far too small to be detected. A. E. G.

1268. *Determination of Coma from a Central Ray.* **T. Smith.** (Phys. Soc., Proc. 29. pp. 298–309; Disc., 309–310, Aug., 1917.)—The absence of coma from an optical system free from spherical aberration can be established by means of the sine condition, from the refraction of rays which originate at the centre of the object. In actual systems spherical aberration is always present to some extent, and the conditions which have to be secured in practical cases do not involve mathematical freedom from spherical aberration and coma, but rather their confinement within predetermined limits. Previous investigations on this subject have been published by Conrady and by Chalmers; the present paper shows that the conclusions of both require some qualification. Conrady's conclusion, that the sine ratio for any zone gives the exact magnification, holds only for rays in a secondary plane, and one of the further conditions (*a*) that the zone is free from spherical aberration, or (*b*) that the stop is at the principal focus for rays travelling in the negative direction, must also be satisfied. Under these conditions the magnification for rays in a primary plane is $[1 + \tan\theta'(d/d\theta')]$ times that for the secondary rays, where $2\theta'$ is the angle subtended by the zone at the centre of the image. The conditions assumed by Chalmers involve the satisfaction of a relation between various quantities, including the curvature and astigmatism of the system; his results may in consequence not apply strictly where very large apertures are involved. Analysis of the general problem shows that the primary and secondary comatic displacements can be accurately derived from the properties of thin oblique pencils of rays. If a central incident ray inclined at θ to the axis is met by an oblique ray in the same axial plane at a distance r from its point of origin, and is refracted at an angle θ' with the axis and meets the image plane at a distance r' from the image of its intersection with the oblique ray, the primary comatic displacement of the oblique ray plus the aberrationless first-order displacement is proportional to $r' \sec\theta'/sr \sec\theta$, where $\mu s/\mu'$ is the magnification in a primary plane for a small normal object at the point of intersection of the two rays. The corresponding secondary displacement is $\rho'/\sigma\rho$, where the Greek letters have the same meaning for secondary rays as the corresponding Roman letters for primary rays. These two quantities determine the coma exactly whatever the spherical aberration may be. It follows that coma is dependent upon the principal surfaces of a lens. When the object is at infinity the coma is determined by the locus of the point of intersection of a ray, incident parallel to the axis, with its refracted portion.

The results established in the paper form one of a series of reciprocal relations which exist between the aberrations of an object and those of the effective stop. AUTHOR.

1269. *Use of Monochromatic Interference Rings for the Measurement of Curvature.* **S. D. Chalmers.** (Phys. Soc., Proc. 29. pp. 362–365, Aug., 1917.)—Shallow convex surfaces can be compared directly with a plane surface, and if the plane surface be placed uppermost, supported at the edge with soft wax, there is only one curved surface to consider. Monochromatic light is used with a measuring microscope, and readings are taken of the diameters of the 3rd and 20th rings. If these are respectively $2C_1$ and $2C_2$, the radius of the curved surface is given by $r = (C_2^2 - C_1^2)/17\lambda$. The 3rd and 20th rings are chosen because 17 × 0·0005893 is very nearly 0·01 mm. and the radius can therefore be quickly evaluated. The same method can, of course, be employed to find the difference of curvature for the case of a convex and a concave surface giving central contact. In the case of edge contacts the standard plates are smaller than the test surface, and are accurate up to the edge, and the method used is to determine the central separation of the two surfaces. The difference of the optical path $n\lambda$ for the two interfering beams at the centre will depend on the angle of incidence, and as the angle is increased the rings will appear to run in to the centre. If p is the number of rings which disappear while the angle of incidence changes from i_1 to i_2, the curvature difference $= p\lambda/(\cos i_1 - \cos i_2)C^2$, where C is the semi-diameter of the standard plate. Details of the method are given, and limits and precautions briefly discussed. A. W.

1270. *Interferences with Large Path-differences.* **G. Gouy.** (Comptes Rendus, 165. pp. 88–92, July 16, 1917.)—In a previous paper [Abs. 1130 (1917)] an expression was obtained for the visibility of interference fringes, taking into account the Doppler-effect and that of molecular impacts. For a first approximation the probability hdt of an impact occurring in the time dt may be regarded as constant. The problem is not so simple if account is taken of the fact that h depends on the velocity of the molecule. This is dicussed in the present paper, and a comparison of Michelson's results for Bunsen flames and electric discharges, and of Buisson and Fabry's results for the iron arc, with results deduced from the kinetic theory, shows that the probability of an impact occurring is much greater than indicated by the kinetic theory. The ratio appears to be (for Bunsen flames) about 14 for Na, 18 for Li, and 21 for Tl, with even greater values for electric discharge spectra. A. W.

1271. *The "Kodachrome" Process of Colour Portraiture.* **C. E. K. Mees.** (Eastman Kodak Co.'s Research Lab., Abridged Sci. Publ. 2. No. 28. pp. 14–16, 1915–1916.)—In the new Kodachrome process a method has been found of transforming a silver negative into a dye positive. The negatives having been made through the correct filters, they are bleached in a bath which transforms the silver into silver bromide and at the same time locally hardens the gelatine in proportion to the silver contained in the negative, so that the gelatine is hardest where there was most silver and remains soft where there was no silver in the negative. On fixing, the plate shows no sign of an image, but when it is put into the dye bath the dye goes into the gelatine most easily where the silver was absent in the negative, that is, where there was least light in the original photograph, or in the part represented by deep shadows; while in the parts corresponding to the high lights, where there was much silver in the negative, the dye penetrates more slowly, so that as the dye slowly enters the film the original negative is transformed into a positive produced in a coloured dye. While the one colour is made in this way, the companion picture is also dyed in the other colour, and the two when placed together make the finished picture. The process is thus seen to be simplicity itself, the novel point of it being the method which has been worked out for transforming a black-and-white negative image into a coloured dye positive. Since only two colours are used in the process, it is obvious that all colours cannot be correctly rendered, and the colours for which the process fails are the blues, violets, magentas and purples. Light blues appear blue-greens, and violets black; magentas appear pink, and purples dark brownish-red. On the other hand, flesh tints of all kinds, and all shades of red, orange or green, greys and blacks are well rendered. As these are predominant in portraits, the results are very satisfying for this class of work. The failure in colour rendering is more obvious by daylight, and because of the importance of greens and blues in most landscapes, the process is not suitable for landscape work. The pictures appear at their best when placed in a special illuminator, giving a much truer colour-rendering than when viewed by daylight. The results are permanent, the colours being fast both to light and heat. [See also Abs. 1116 (1917).] A. E. G.

1272. *Equality Point in Spectral Energy and Luminosity Distribution Curves.* **M. Luckiesh.** (Frank. Inst., J. 183. pp. 683–684, May, 1917.)—In plotting energy-distribution curves of the spectrum of illuminants it is convenient to select a wave-length of equality. These values are commonly multiplied by the spectral visibility values to obtain the luminosity-distribution, but curves so obtained cannot, when integrated, be compared on the basis of equal luminous efficiency or luminous intensity. It is of interest to compute the relative integral luminosities of curves with equality-points at various wave-lengths. This has been done for a variety of illuminants, including noon sunlight and blue skylight. With this extreme range of colour-values, comprising also vacuum and gas-filled tungsten lamps, carbon filament lamps, the Welsbach mantle, and the Hefner lamp, an equality point near 0·565 μ yields the best results. This is illustrated by a diagram. For the most common artificial illuminants an equality point near 0·575 μ yields results closely proportional to the integral luminosity value. This is in close accordance with Crova's method involving comparisons at 0·582 μ for illuminants which do not depart widely from the radiation of a black body. J. S. D.

1273. *On the Theory of the Opalescence Radiation.* **E. Buchwald.** (Ann. d. Physik, 52. 8. pp. 776–815, Sept. 6, 1917.)—The theory of radiant energy dispersion by a system of resonators, of which opalescence radiation is a particular case, is based on the physics of oscillations. Here, as in the case of radio-activity, a particular variable and its oscillations are concerned. The present paper contains a detailed mathematical exposition of the theory of opalescence radiation. The general conclusions evolved are:—(1) The opalescence field of a gas enclosed in a cube is made up of the diffraction phenomena at the cube and the special opalescence radiation. (2) The oscillations of the field and the intensity of the opalescence are calculated by the motion of resonators. (3) For evolving the exact calculation in the case of dense resonator formation (reciprocal influence of the resonators), the succession of the agents (temporal and constellation) may be interchanged so that only diffraction phenomena at the cube are given and no opalescence radiation. (4) The entrance or disappearance of opalescence radiation according to the succession of the agents is investigated, and the relationship of irregular and regular disposition of the resonators towards the production of opalescence radiation established. H. H. Ho.

1274. *Photoelectric Photometry.* **J. Kunz.** (Astrophys. J. 45. pp. 69–88, March, 1917.)—A more complete account of the work dealt with in Abs. 124 (1917).

1275. *Origin of Line Spectrum emitted by Iron Vapour in the Explosion Region of the Air-Coal Gas Flame.* **G. A. Hemsalech.** (Phil. Mag. 34. pp. 221–242, Oct., 1917.)—Continuing his previous work [Abs. 222 and 495 (1917)] the author has now undertaken research with the object of investigating more fully the physical and chemical conditions which govern the emission of the cone lines, and also of gaining a clue to the particular chemical actions which underlie their excitation. The methods of producing and feeding the flames, as also the spectroscopic apparatus, were the same as in the earlier work. The results of the investigation show that there is no connection between the chemical actions which underlie the emission of the carbon bands and those to which the characteristic cone spectrum of iron is due. The relative behaviour of iron lines emitted by the mantles of various flames is such as to suggest their being in a great measure controlled by the temperatures of these flames. It has been shown that nitrogen is one of the determining factors in the emission of the characteristic cone spectrum of iron. In order to account for the origin of this spectrum a hypothesis has been proposed based on the assumption that a nitride of the metal is formed in the explosion region. The presence of ammonia in the air-coal gas and oxy-coal gas flames reduces the reaction between nitrogen and iron to a considerable extent. The decomposition of the ammonia in the cones of these flames seems to initiate the emission of the so-called cyanogen bands. The presence of oxygen in the medium surrounding the air-coal gas flame is essential in bringing about the formation of iron nitride in the explosion region of this flame. No reaction takes place if all the oxygen is withdrawn from the gas mixture of an air-coal gas flame burning in an atmosphere of air. Heating an air-coal gas flame by means of a graphite rod kept at a bright red heat only slightly increases the intensities of the iron lines. Cooling the flame decreases their intensities. Experiments are described which prove that the higher velocities of the oxy-hydrogen and oxy-acetylene flames do not account for the absence in the cones of these flames of the supplementary spectrum of iron. The results of the investigation serve to emphasise the importance of chemical reactions in the excitation of both line and band spectra. In particular, the fact that a well-developed line spectrum of a metal vapour can be obtained by this means at a comparatively low temperature may be worthy of serious consideration in the interpretation of astrophysical phenomena. A. W.

1276. *Canal Rays of Carbon, Silicon, and Boron.* **G. Wendt.** (Ann. d. Physik, 52. 8. pp. 761–774, Sept. 6, 1917.)—A continuation of previous work [Abs. 1960 (1913)]. The canal-ray tube was the same as that used by Stark, Fischer and Kirschbaum [Abs. 982 (1913)]. A Hartmann microphotometer was employed to measure the intensity of blackening on the spectrograms. Curves are given of the results obtained for the various lines investigated. The curves show that carbon may have both singly- and doubly-charged atomions as carriers of the lines in its canal-ray spectrum. The carbon line λ2478 has for carrier the positive singly-charged atomion, while the carrier for the line λ4267 is doubly charged. Silicon follows Al in atomic weight, but only singly- and doubly-charged atomions were found for the Si canal-ray lines, Al giving lines whose carriers are triply charged. The silicon lines λλ2436, 2507, 2516, 2519, 2524, 2529, and 2882 were all found to have as carriers the positive singly-charged atomion, the carrier for the line λ4132 being doubly charged. The boron doublet λ2496·7 was found to have as carrier the singly-charged atomion, while that for the line λ3451 is doubly charged. The observations on the latter line showed that it is possible boron may have lines whose carriers are triply charged, and which are beyond the limits of the spectrograph employed. A. W.

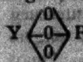
1277. *The Limiting Frequency in the Spectra of Helium, Hydrogen, and Mercury in the Extreme Ultra-violet.* **O. W. Richardson** and **C. B. Bazzoni.** (Phil. Mag. 34. pp. 285–307, Oct., 1917.)—The investigations described in this paper were undertaken for the purpose of detecting and measuring the frequency of the shortest vibrations emitted from the various gas atoms under electron impacts; a preliminary notice has already been published [Abs. 1246 (1916)]. The more important results of the investigation are now summarised as follows:—The high-frequency limits of the spectra of helium, hydrogen, and mercury when stimulated by large electron currents under potentials up to 800 volts have been determined. The measurements are believed to be most accurate for He and least accurate for Hg. The He spectrum extends to a limit which is certainly between 470 and 420 and probably near to the latter value. The hydrogen spectrum terminates at a wave-length between 880 and 950 Å.U. and probably close to 900. The mercury spectrum terminates at a wave-length between 1000 and 1200 Å.U. So far as it was possible to ascertain, the observed terminal frequencies are identical with the frequencies calculated from Bohr's theoretical values of the ionisation potentials of the respective gases, and they exhibit no obvious relationship to the ionisation potentials which have been determined experimentally by Franck and Hertz and others. The ultra-violet spectrum has been extended to a wave-length which is certainly shorter than 470 and probably close to 420 Å.U. The high-frequency limits of the spectra referred to are independent of the applied potential up to about 800 volts, provided this potential exceeds a lower limit which has not been determined accurately. A. B. W.

1278. *Ionisation and Radiation in Mercury Vapour and Hydrogen.* **B. Davis** and **F. S. Goucher.** (Phys. Rev. 10. pp. 101–115, Aug., 1917.)—Certain facts brought to light by the experimental results obtained by Franck and Hertz, Tate, Goucher, and McLennan and Henderson [Abs. 1274 (1916) and 64 (1917)], rendered it desirable to determine whether the effects occurring below 10·4 volts in mercury vapour were due to ionisation or to the emission of ultra-violet light from the bombarded atoms, and whether or not positive ionisation actually took place at 10·4 volts. For the purpose of testing these possibilities, a modification of the ordinary Lenard method was adopted, the modification consisting essentially in the introduction of a second gauze in the apparatus employed in the regular Lenard method, and a constant field was maintained between this gauze and the collecting electrode throughout the measurements. The results of the experiments with mercury vapour show that radiation is emitted without ionisation at an impact voltage of 4·9 volts. This voltage corresponds to the frequency of the first line λ2536·7 of the Paschen combination $\nu = 2p - mS$, as has previously been pointed out. An increase in the intensity of the radiation takes place at an impact voltage of about 6·7 volts. This voltage corresponds to the frequency of the first line λ1849 of the principal series $\nu = 1{\cdot}5S - mP$ of this combination. Ionisation by impact, without an apparent increase in radiation occurs at an impact voltage of about 10·4 volts, which corresponds to the head, or shortest wave-length, of this same principal series. On account of its theoretical interest in connection with Bohr's theory, the same experimental method was employed to investigate the effects in hydrogen, and the following results were obtained: Both ionisation by impact and emission of radiation occur at 11 volts. A second type of radiation without an increase of ionisation is emitted at 13·6 volts, and a second type of ionisation by impact without increase of radiation occurs at about 15·8 volts. These facts show a greater complexity than the simple Bohr theory of the atom would predict, but are not inconsistent with it. The voltage corresponding to the head, or shortest wave-length, of the Lyman series is 13·6 volts.

while that for the tail, or longest wave-length, of the series is 10·2 volts. There is thus a marked difference in the behaviour of hydrogen and mercury vapour, the latter showing radiation at a voltage corresponding to the longest wave-length and ionisation without radiation at the head of the series. There is no radiation from hydrogen at 10·2 volts, and this may be due to the fact that the corresponding radiation is very weak, or that some of the energy of the impacting electron is transformed into kinetic energy of the hydrogen atom. The latter is quite probable, since the impacts in hydrogen are not elastic as in mercury vapour. The occurrence of a new type of ionisation by impact at 15·8 volts instead of 18·6 volts can also be accounted for on the hypothesis that the hydrogen atom has a certain affinity for an electron. Other diatomic non-elastic gases will be examined, to determine if they behave in a similar manner. A. W.

1279. *Triboluminescence.* **A. Imhof.** (Phys. Zeits. 18. pp. 874–880, Aug. 15, 1917.)—A continuation of previous work [Abs. 501 (1917)]. A hypothesis as to the origin of triboluminescence is advanced, and this is discussed at length in the light of the experimental results previously obtained. A. W.

1280. *Results of Crystal Analysis.* IV. **L. Vegard.** (Phil. Mag. 33. pp. 395–428, May, 1917.)—The first part of the paper deals with the structure of ammonium iodide (NH_4I) and tetramethylammonium iodide [$N(CH_3)_4I$]—two crystals which show interesting morpho-tropic relations. Groth derives the structure of $N(CH_3)_4I$ from that of NH_4I by simply substituting the group CH_3 for the H-atoms in the latter crystal, and the hypothetical lattices given by him for the two crystals show several striking points of similarity with those actually found by experiment; the author, however, shows that the morphotropic relations existing between the two substances is not quite so simple as that supposed by Groth. From X-ray spectrometer measurements lattices are obtained for the two crystals which explain the observed results satisfactorily, but a further investigation is necessary before the exact positions of the H-atoms can be determined. The analyses of the crystals shows that a simple relation between the topic parameters does not necessarily involve any very simple relation between the lattices.

The second part of the paper is devoted to some additional considerations regarding the structure of xenotime (YPO_4) [see Abs. 504 (1917)]. Considerable difficulty was previously experienced in obtaining reflections from this crystal on account of an internal transformation of the structure. Further observations have been taken with improved apparatus, several weak maxima being now observed where previously no maxima could be detected, with the result that the similarity of the structure of xenotime and zircon became much more marked. The new measurements do not call for any alteration in the arrangements of the Y and P atoms, but the oxygen atoms have to be rearranged to explain the observed maxima. The dimensions of the lattice remain unaltered, and it is concluded that the lattice of xenotime is of the same type as that of zircon. This fact has far-reaching consequences, which bear on the relations existing between chemical constitution and crystal structure. The structure already found for zircon, rutile, and cassiterite indicates that these substances may be represented by the constitution formulæ ZrO_2SiO_2, $(TiO_2)_2$ and $(SnO_2)_2$ respectively. As the atoms of xenotime (YPO_4) are arranged in a lattice of the zircon type, this substance should by analogy have the constitution formula YO_2PO_2. If xenotime be regarded as a phosphate, its chemical constitution formula would be  $Y\left\langle\begin{matrix}O\\O\\O\end{matrix}\right\rangle P=O$, which puts one of the oxygen atoms in a singular position, and if the valency units are to indicate forces, the Y-atoms would be attracted to the P-atoms, so far as chemical attraction is concerned, only by means of the oxygen atoms. Further, this chemical constitution formula gives no indication as to the true arrangement of the atoms. Hence although it is found that the constitution of the solid state of zircon, rutile, and cassiterite should be ZrO_2SiO_2, $(TiO_2)_2$, and $(SnO_2)_2$ respectively, it cannot be concluded that these are adequate expressions for the chemical properties of the substances. The ordinary chemical constitution formula is intimately related to the idea of a molecule, but in the crystalline state the idea of a molecule as an individual system has lost its significance. This fact alone goes far to explain why the chemical constitution formula ceases to express the structure of solids.

The final conclusion arrived at is that substances belonging to the zircon group—xenotime included—have in the crystalline state a structure corresponding to the formula $M_1O_2 . M_2O_2$, which might be called the constitution formula of the solid state; this constitution formula may, however, be quite different from the chemical constitution formula of the substances, or from the constitution of the liquid, gaseous, or ionic form. E. A. O.

1281. *Crystal Structure of Magnesium.* **A. W. Hull.** (Nat. Acad. Sci., Proc. 3. pp. 470–473, July, 1917.)—An X-ray analysis was first made of single small crystals of magnesium. The photographs thus obtained gave the approximate structure. A photograph was then obtained, using magnesium powder (method described in Phys. Rev. 9. p. 85. Jan., 1917), confirming the results of the first method.

A table is given showing the position of the observed lines and the corresponding spacing of the planes, together with the theoretical spacing for a lattice composed of *two* sets of triangular prisms, the atoms of either set being in the centre of the prisms of the other. The agreement is within the limits of experimental error. A. B. W.

1282. *X-ray Measurements and Methods.* **R. Glocker.** (Phys. Zeits. 18. pp. 302–315, July 1, and pp. 330–338, July 15, 1917.)—Forms a compact summary of the various methods adopted for measuring intensity and hardness. A brief chapter on dosimetry is appended. L. H. W.

RADIO-ACTIVITY.

1283. *Existence of a Third Fundamental Radio-active Substance in the Uranium Series.* **A. Piccard.** (Archives des Sciences, 44. pp. 161–164, Sept., 1917.)—The author formulates a hypothesis as to the existence of a hitherto unknown substance and attempts to show that this hypothesis explains several enigmas without introducing fresh contradictions. Up to the present it has been supposed that two simple substances, the isotopes U_I and U_{II}, occupy in the periodic system the place designated "uranium." The author now introduces a third element into the series, this substance being called "Actinuranium" (AcU). This substance has the following characteristics:—(1) AcU does *not* belong to the Ur-Ra family, but it is at the head of the actinium series. (2) It is not produced by any simple substance at present in existence on the earth; its length of life is consequently very long, which places this substance in a category similar to U_I and thorium. (3) Its atomic weight is greater than that of U_1, hence greater than all other known atomic weights. (4) The atom AcU, on emitting an α-particle, is transformed into a substance generally referred to as UY, which by successive transformations originates the actinium family.

The author subsequently produces evidence in favour of his hypothesis.

A. B. W.

1284. *Theory of Decay in Radio-active Luminous Compounds.* **J. W. T. Walsh.** (Roy. Soc., Proc. 93. pp. 550–565, Oct. 9, 1917.)—Paterson, Walsh and Higgins [Abs. 933 (1917)] have shown that the luminosity of radium luminous compound at first rises rapidly to a maximum and then decreases, according to an exponential law, for about 200 days. After this time the rate of decrease of luminosity becomes slower and slower, so that the brightness tends to approach a limiting value which is not zero. Rutherford's theory [Abs. 77 (1911)] of the phenomenon gives a good approximation during the early period of decay, but fails increasingly at the later period. Rutherford's theory of the *destruction* of "active centres," combined with the author's theory of *recovery* of "active centres" gives a much more accurate representation of the observed facts. It is assumed that "active centres" which have been struck by α-particles (and, according to Rutherford's theory, are put completely out of action from the point of view of luminescence) commence to *recover* according to an exponential law. From the equations of decay deduced, it is quite a simple matter to calculate the values of brightness throughout the life of the sample, as well as to deduce the *total* light emitted in a given time.

A. B. W.

1285. *Absorption of γ-rays.* **B. Keetman.** (Ann. d. Physik, 52. 7. pp. 709–735, Aug. 16, 1917.)—A detailed description is given of a series of measurements on the absorption of γ-rays emitted by radium and mesothorium. It is shown that the ionisation produced by the γ-rays increases with increasing atomic weight of the material forming the walls of the ionisation chamber. This effect becomes more pronounced for the more penetrating γ-radiation. The absorption coefficient for γ-rays is in a high degree dependent on the size of the absorbing screen and on its position between the source of radiation and the ionisation chamber. This phenomenon is due to scattering of the radiation.

The author states that all values of absorption coefficients hitherto published are uncertain since they are dependent on the apparatus employed in the determination. A method of determining the *Umwandlungskoeffizienten* is now described, which the author considers is quite free from objection. The values obtained by this method are uniformly higher than those obtained by other methods.

The γ-rays from Ra(B + C + D), Mesothorium II, and Th(B + C + D) have been analysed.

A. B. W.

1286. *Radio-activity of Meteorites.* **T. T. Quirke** and **L. Finkelstein.** (Am. J. Sci. 44. pp. 237–242, Sept., 1917.)—Although the determinations of the radio-activity of various rocks are numerous, the radio-activity of meteorites is known for only two varieties and for only three specimens. The author now gives the result of his determinations of the radium content of 22 meteorites. From the data it appears that the average stony meteorite is considerably less radio-active than the average igneous rock (probably less than one-fourth as radio-active as an average granite) and that the metallic meteorites are almost free of radio-activity.

A. B. W.

HEAT.

1287. *Note on the Specific Heat of Water.* **W. R. Bousfield.** (Roy. Soc., Proc. 93. pp. 587–591, Oct. 9, 1917.)—The author discusses the values of the specific heat of water previously obtained by him in view of criticisms made by Callendar [Abs. 875 (1912)]. He is prepared to accept the greater accuracy of Callendar's results in the region of higher temperatures, but points out that Callendar's new experiments have only a remote bearing on the values in the lower range—up to 55°—and the true position of the minimum. According to the determinations of the author this occurs at 25° C.; according to Callendar and Barnes, at 38° C. The author upholds his previous results, which are in agreement with those obtained by other investigators, though deviating from those of Callendar and Barnes. A. F.

1288. *Uniform Movement of Flame in Mixtures of Acetylene and Air.* **W. A. Haward** and **S. G. Sastry.** (Chem. Soc. J., Trans. 111. pp. 841–843, Sept., 1917.)—The authors have determined, for mixtures of acetylene and air, the speeds of the "uniform movement" which occurs when the inflammable mixtures of gases is ignited at the open end of a horizontal tube closed at the other end. Tubes 12 mm. in diam. were employed. For mixtures containing less than 8 % of acetylene, the speed of uniform movement of the flame increases rapidly with increase in the amount of acetylene; for mixtures containing from 8 to 10 % of acetylene, the speed is nearly independent of the composition; and for mixtures containing more than 10 % of acetylene, the speed decreases with increase of acetylene. The speed of the flame in mixtures containing more than 20 % of acetylene decreases gradually as the percentage of acetylene is increased. The mixture of acetylene and air for complete combustion contains 7·75 % of acetylene; the fact that the fastest speed of flame is found in mixtures containing rather more than this can be explained on the assumption that the thermal conductivity of acetylene is higher than that of air. A. F.

1289. *The Clustering Tendency of the Molecules at the Critical Point.* **L. S. Ornstein.** (K. Akad. Amsterdam, Proc. 19. pp. 1321–1324, 1917.)—In a former communication by F. Zernike and the present author [see Abs. 777 (1915)] the arrangement of the molecules in space using a new method of probability is described more accurately than this was possible in the considerations of v. Smoluchowski and Einstein. By this method it was also possible to calculate the opalescence at the critical point itself, which was impossible with the formulæ of Keesom-Einstein. A function "f" was introduced, defined in the following way:—Suppose that space is divided into a great number of elements of volume dV_0, $dV_1 \ldots$, dV_n, etc., and that the numbers ν_0, ν_1, etc., represent the deviations of the average number of molecules in these elements, then, if the deviations in all the surrounding elements of the working sphere are given, the average deviation in the element dV_0 may be represented by $\bar{\nu}_0 = f_{01}\nu_1 dV_1 + f_{02}\nu_2 dV_2 + \ldots$, the coefficients f_{01}, etc., indicating the correlation of the elements. In a homogeneous phase they will only depend on the distance between the elements, whereas in a capillary transitory layer the function will be different. In the former paper difficulties were encountered in the kinetic deduction of the above formula owing to the fact that, mathematically, infinitely small elements of volume were considered. Zernike having recently solved another difficulty while adhering to previous considerations, the present author now demonstrates a deduction of the above formula from statistical mechanics. The physical meaning of function "f" is indicated, and the proof given that $\int dV$ taken with respect to the working sphere is at the critical point equal to unity—a result formerly demonstrated by an artifice. The author opines that his results may easily be extended to the case of a mixture and the capillary layers in a mixture, so that it should be possible to develop Mandelstamm's considerations on the diffuse reflection at the layer of contact between two liquid phases at the critical point of a mixture more exactly than he himself has done. H. H. Ho.

1290. *Entropy of a Real Gas as a Function of the Average Spacial Temperature- and Density-distribution.* **R. Fürth.** (Phys. Zeits. 18. pp. 395–400, Sept. 1, 1917.)—Frank has recently shown that the entropy of an ideal gas may be utilised as a measure of the uniformity of temperature- and density-distribution, and he establishes the following formula for the entropy S of the gas: $S = S_0 - \frac{1}{2}\left[c\left\{(T - T_0)/T_0\right\} + R\left\{(s - s_0)/s_0\right\}^2\right]$, where S_0 is the entropy in the normal state, c the specific heat at constant volume, R the absolute gas-constant; T and s are respectively the temperature and density of a volume element of the gas, and T_0 and S_0 the spacial average value of these magnitudes. The cross line likewise signifies spacial average over all volume elements. This formula shows that the entropy has its max. value if temperature and density are distributed uniformly over the volume elements of the gases, and it must be regarded as a second fundamental condition for this state. The author now extends the scope of the above formula to the case of a real gas, first deriving an equation of state other than that from the laws of Boyle and Charles, from which he deduces the relationship between entropy and the distribution of temperature and density. In connection with this extension Boltzmann's theory is utilised together with Smoluchowski's formula for the average density variations of a gas in the neighbourhood of the critical state. The entropy formula established for a real gas is $S - S_0 = -\frac{1}{2}\left[c\left\{(T - T_0)/T_0)\right\}^2 - \partial p/\partial v \,.\, V^2/T_0 \,.\, \left\{(s - s_0)/s_0\right\}^2\right]$, where the nomenclature is as above. This formula shows that the entropy can be expressed as a function of the temperature- and density-distribution in the gas.

The second part of the paper contains a mathematical discussion of this entropy formula, while Section 8 of the paper shows how the formula may be used in conjunction with Boltzmann's principle for the calculation of the average deviation in the neighbourhood of the critical state. The result obtained is identical with the expression derived from kinetic considerations. H. H. Ho.

SOUND.

1291. *Alterations of Tone produced by Violin Mute.* **C. V. Raman.** (Nature, 100. p. 84, Oct. 4, 1917.)—Experiments on the "wolf-note" of the violin and 'cello [Abs. 1052, 1366 (1916)] suggested an explanation of the well-known and striking alterations in the tone of the instrument produced by a "mute," which at first sight seems somewhat difficult of acceptance. It is that they are due to the lowering of the pitch of the free modes of vibration of the *entire body of the instrument* produced by the added inertia. This view of the mute's action has excited some incredulity, and its correctness has been questioned by J. W. Giltay [Abs. 1160 (1917)]. The present note is put forward to establish the correctness of the author's view of this important phenomenon.

If N_1, N_2, N_3, etc., be the frequencies of the free vibrations of the body (in ascending order), the frequencies as altered by the addition of the mute are determined by equating to zero the expression (see Routh's "Advanced Rigid Dynamics," Sec. 76), $(N_1^2 - n^2)(N_2^2 - n_2) \times$, etc., $- an^2(n_2^2 - n^2)(n_3^2 - n^2) \times$, etc., where a is a positive quantity proportionate to the added inertia, and n_2, n_3, etc., are the limiting values of N_2, N_3, etc., attained when the load is increased indefinitely ($n_1 = 0$, and $n_2 < N_1$, $n_3 < N_2$, etc.). The forced vibration due to a periodic excitation of frequency n is determined by the same expression, being inversely proportional to it except in the immediate neighbourhood of points of resonance. The sequence of the changes in the forced vibration produced by gradually increasing the load is sufficiently illustrated by considering a case in which n lies between N_1 and N_2. If $n < n_2$ the load decreases the forced vibration throughout, but if $n > n_2$ the load at first increases the forced vibration until it becomes very large, when n coincides with one of the roots of the equation for free periods, subsequent additions of load decreasing it. The *increase* in the intensity of tone indicated by this theory has actually been observed experimentally by Edwards in the case of the graver tones and harmonics of the violin [Abs. 685 (1911)]. Edwards's observation that the intensity of tones and harmonics of high pitch is *decreased* by "muting" is also fully explained on this view, as in the case of the higher nodes of free vibration of the instrument a very small load would be sufficient to make the frequencies approximate to their limiting values.

The author's explanation is also supported by his experiments on the 'cello, in which the two feet of the bridge were loaded in turn and then the top of the bridge. E. H. B.

1292. *Resonance Theory of Hearing.* **A. L. Bernoulli.** (Phys. Zeits. 18. pp. 817–819, July 15, 1917.)—A criticism of the position taken by E. Budde on some aspects of the subject. [See Abs. 996 (1917).] **E. Budde.** (Ibid. 18. pp. 819–821, July 15, 1917.)—Budde replies to Bernoulli defending the position previously taken. E. H. B.

1293. *Forced Vibrations.* **E. Budde.** (Phys. Zeits. 18. pp. 285–290, July 1, 1917.)—Remarks on two papers by E. Waetzmann, one referring to the forced vibrations of a particle with one degree of freedom on double forcing, the other on the equations of motion of the telephone membrane in a microphone-telephone circuit. [See Abs. 915 (1911), 294 (1914).] E. H. B.

1294. *Sound Fields and Antennæ.* II. **W. Hahnemann** and **H. Hecht.** (Phys. Zeits. 18. pp. 261–270, June 15, 1917.)—In a previous paper the authors treated radiating bodies of the zero order. They now pass on to a mathematical treatment of sound-sources of the first order. The former case is illustrated by a pulsating sphere in which the motions are purely radial; the latter by the addition of tangential motions. The case of vibrating membranes is also dealt with in the present paper. [See Abs. 242 (1917).] *Erratum.* (Ibid. p. 368, Aug. 1, 1917.) E. H. B.

1295. *Audibility Regions of East London Explosion.* **C. Davison.** (Quarterly Review, No. 452. pp. 51–60, July, 1917. Nature, 99. p. 450, Aug. 2, 1917. Abstract.)—The sound-area consisted of two detached portions. The inner one was distorted in two main directions. Towards the east-south-east it reached Canterbury, 48 miles, and to the north-west Wellingborough, 66½ miles; but to the north-east and south the boundary is only 19 or 20 miles from the source. The outer sound-area reached from near Nottingham, across the south of Lincolnshire and Norfolk, to, and no doubt beyond, the east coast of the latter county. The most distant place at which the sound was certainly heard is Stow, near Lincoln, 128 miles. The width of the silent zone varied from 28 miles at the western and higher end to 48 miles at the eastern end. [See Abs. 529 (1917).] E. H. B.

1296. *Energy Absorption in Sound Antennæ.* **H. Lichte.** (Phys. Zeits. 18. pp. 393–395, Sept. 1, 1917.)—It is shown that the energy absorbed by a radiator of zero order placed in a sound-field is proportional to the square of the wave-length. This and other results are in qualitative agreement with those for the antennæ of wireless telegraphy. [See Abs. 242 (1917).]
E. H. B.

1297. *Experimental Phonetics.* **D. Jones.** (Nature, 100. pp. 96–98, Oct. 4, 1917. Abstract of paper read before the Roy. Inst., Feb., 1917.)—Instructions how to pronounce a foreign language, in order to be efficacious, must be based on accurate analysis of the pronunciation. Many of the facts of pronunciation can be ascertained by direct observation on the part of those who have specially trained ears and highly developed control over their vocal organs. But, to supplement the foregoing methods, mechanical analysis by means of specially designed apparatus may be used. Analysis of this kind constitutes the branch of phonetics known as *experimental phonetics.*

The methods of mechanical analysis here referred to are (1) the *palatogram,* (2) H. W. Atkinson's *mouth measurer,* (3) X-ray photographs, and (4) the *kymograph* [see Nature, p. 285, June 7, 1917]. The palatogram is a figure of the spaces of contact of palate and tongue for a particular sound. It is obtained by inserting a thin artificial palate in contact with the hard palate. The artificial palate is dusted on its lower side with chalk before insertion. Then, after pronouncing the sound under test, the removal of the chalk dust at certain places gives the information required. The mouth measurer consists of a tube which may be inserted in the mouth with an adjustable stop on the front teeth. A wire is then protruded through this tube to the requisite distance to touch the tongue. These contacts are made for a number of places, and so the contour of the tongue is ascertained and recorded. To show by X-rays the position of the tongue a little chain of lead plates is laid upon it.

The article is illustrated by five diagrams, five X-ray graphs, and eleven voice graphs. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1298. *Relativity and Electromagnetic Mass of Parson's Magneton.* **D. L. Webster.** (Phys. Rev. 9. pp. 484–499, June, 1917.)—The *magneton* is a non-spherical electron consisting of a thin ring on which a negative charge revolves at a speed of the order of that of light, and is therefore a combination of electrostatic and steady magnetic properties [see Abs. 154 (1916)]. The author shows that the relativity principle would necessitate certain assumptions as to the internal forces in the magneton, or any other non-spherical system, producing a kind of mass which, added to the electromagnetic mass, will make the total mass constant. Making these assumptions in what seems the most plausible way, the mass of the magneton is found to be $2/c^2$ times its electrostatic energy, where c is the speed of light. This result leads to a formula for the mass by which the very small cross-section radius may be expressed in terms of the radius of the ring. G. W. DE T.

1299. *Electromagnetic Equations.* **A. C. Crehore.** (Phys. Rev. 9. pp. 445–479, June, 1917.)—The author's objective is to find whether it may not be possible to bring atomic phenomena, including those connected with radiation, within the scheme of the electromagnetic equations of the so-called "classical dynamics," perhaps by substituting one of the possible alternative forms of the potential function for the form hitherto generally selected. For if the ether be accepted as real, and the electromagnetic equations regarded as the mere formal expression of its properties, it is difficult to conceive that the individual electrons can fail to lie within its domain. The single assumption is made that the electrons in material atoms move uniformly in circular orbits at zero temperature. The Lorentz form of electromagnetic equations are then applied to them, and it is found that a change in certain terms of the equations is requisite in order that they may be applicable to the atoms, and the results of the investigation appear to suggest a probable alteration, either of the assumed equation $\mathrm{Div}\ a + \dot{\phi}/c = 0$ completing the determination of the relation between the vector potential a and the scalar potential ϕ, or of the assumed connection between charge and ether. A general expression is obtained, without making any such alteration, for the average force between two electrons moving in circular orbits, as the sum of a series of the inverse powers of the distance between the centres of the two orbits, beginning with the first, and including all higher powers. When this force, not generally directed along the line joining the centres of the orbits, is resolved in this direction, the first powers disappear, and, at sufficient distances, the values depend only on the inverse second power, in this resembling gravitation. This is shown to be true in the case of two crystals as well as for other forms of matter, including gases, liquids, and solids. The attraction between two diamond crystals, assumed to be 10^{-6} cm. on an edge, is determined from the average calculated attraction between two electrons, one in each cube, the carbon atom being supposed, in accordance with the author's previous investigations, to contain 12 electrons in two rings, the outer one containing 8 and the inner one 4, and is found to be more than 10^{31} times the value calculated from the gravitational constant. This shows that something is fundamentally wrong, *i.e.* either the electron orbits are not uniformly described circles, or the ordinarily accepted electromagnetic equations are not applicable to the electrons. The author selects the latter alternative, in which he is in agreement with many physicists. Although not, so far, successful in finding a form for the potential functions which would reconcile the discrepancy, he has found a significant physical factor which, introduced into the inverse square terms in the expression for the force between two electrons, gives the gravitational force correctly within about 1 %. The factor is $\frac{1}{4}m\beta^2$, when m is the mass of either one of the cubes, and β_1 is the velocity, relatively to that of light, of the orbital speed of the single electron in one cube the averaged attraction on which of the 12 electrons in an atom of the other was the starting-point of the calculation. The author seems to be justified in his suggestion that the nature of this factor may be taken as an indication of his being on the right track. The author finds, moreover, that the modified equation gives for the equilibrium speed of rings of electrons a value closely approximate to that derived from the original form, and, when applied to the determination of the elastic forces brought into play by compression of the diamond, in such manner as not to alter the angles of the space-lattice formation, leads to a value of the right order for the bulk modulus. G. W. de T.

DISCHARGE AND OSCILLATIONS.

1300. *Ionisation Potential of Electrodes in Various Gases.* **F. M. Bishop.** (Phys. Rev. 10. pp. 244–252, Sept., 1917.)—The object of the present investigation was to redetermine the ionising potential of certain gases under different experimental conditions, and to extend the work to some simple compounds and see if the combination of one atom with another had any effect on its ionising potential. The method employed was essentially that described by Franck and Hertz [Abs. 659 (1913)], Pawlow, and Goucher [Abs. 64 (1917)] in which plate electrodes are used. Results obtained by various experimenters using a plate illuminated by ultra-violet light as the source of electrons differ so much from those obtained when a hot wire or Wehnelt kathode was employed, that a comparison of the two methods seemed desirable, and in the apparatus used either method could be employed. The results of the investigation show that the method in which electrons are liberated by ultra-violet light gives misleading results, because the number of electrons set free is too small. This fact explains the discrepancy between the values of the ionising potential obtained by this method and those found when the source of electrons is a hot metal surface. The ionising potential of several gases was determined under conditions which tend to minimise the photoelectric effect on the receiving electrode due to radiations in the tube. Results were obtained in good agreement with the accepted values for the following gases: oxygen, 9 volts; nitrogen, 7·5 volts; hydrogen, 11 volts. In hydrogen, in addition to the ionisation which begins at 11 volts, a second and more intense type was found which begins at about 15·7 volts. For mercury vapour no ionisation could be detected below 10·27 volts, which is in agreement with the recent work of Goucher and Davis. The ionising potential of nitrous oxide was measured and found to be identical with that of nitrogen. The curve obtained was almost an exact duplicate of the ionisation curve for nitrogen, which shows that in this case at any rate the ionisation potential of nitrogen is not affected by its chemical combination in a compound. Ionisation was increasing too rapidly by the time the ionising potential of oxygen was reached for any variation in the slope of the curve at this point due to oxygen to be detected. A. W.

1301. *Emissions of Electrons and Positive Ions from Glowing Filaments.* **W. Hüttemann.** (Ann. d. Physik, 52. 8. pp. 816–848, Sept. 6, 1917. Extract of Dissertation, Berlin.)—The paper is divided into two sections, the first of which deals with the emission of electrons from metal filaments at high temperatures. The second portion of the paper deals more especially with the chemical nature of the positive ions which are emitted from hot filaments of different kinds. A lengthy description is given of the apparatus and methods of measurement employed in the investigation. The principal results are summarised as follows:—

Section I.—Tungsten and tantalum when glowing emit electrons, the number of which is in agreement with Richardson's formula. This holds good up to a temperature of 2069° C. for W and 2097° C. for Ta. Further investigation up to the melting-points of these metals yields inconsistent and unreliable results on accouut of the change of surface area of the filaments at such temperatures. The number of electrons emitted at "equivalent" temperatures is always greater for W than for Ta. The "initial" voltage was found to be 5·0 for W and 4·3 for Ta, and the minimum amount of energy required for an electron to escape from the surface, $7{\cdot}82 \times 10^{-12}$ and $6{\cdot}72 \times 10^{-12}$ erg respectively.

Section II.—Platinum, tungsten, tantalum, and aluminium oxide all emit positive ions, whilst calcium oxide does not. The number of positive ions emitted at the beginning of the *Glühzustand* is greater for Pt, W, and Ta than for aluminium phosphate. In all the cases examined, positive ions of hydrogen atoms, hydrogen molecules and metal atoms were found. A band $m/H = 30$ was also noted for these filaments, and the supposition is made that it is due partly to oxygen and partly to CO. A. B. W.

1302. *Ionisation of Potassium Vapour by Ordinary Light.* **J. A. Gilbreath.** (Phys. Rev. 10. pp. 166–170, Aug., 1917.)—There has been some doubt as to whether the vapours of the alkali metals are photoelectric under the influence of ordinary light. Anderson found that potassium vapour was ionised by ultra-violet light [Abs. 1026 (1913)], but Hughes has suggested that the photoelectric currents observed by Anderson were not due to the vapour, but were surface effects. The present investigation was accordingly made to determine whether or not potassium vapour is ionised by ordinary light. A tube with parallel plate electrodes was used, the tube being of ordinary glass impervious to ultra-violet light. The electrodes were of copper, about 2 cm. wide by 3 cm. long, and separated by a space of 1 cm. The solid potassium, distilled *in vacuo*, was in a small auxiliary bulb connected direct to the end of the discharge tube. The currents were measured by a sensitive quadrant electrometer, which was connected to one of the electrodes. With zero potential at the other electrode no currents were obtained in any case, but with a potential of from 300 to 400 volts distinct photoelectric currents were observed. The magnitude of the current was very nearly the same whether the beam of light employed passed between the electrodes or was directed first on one electrode and then on the other. When the temperature of the main part of the discharge tube was raised, and the vapour driven into the cold bulb, the photoelectric currents decreased. The currents also decrease when the bulb temperature is lowered, thereby decreasing the pressure of the vapour throughout the tube. Again, ionisation currents of approximately the same magnitude were obtained with both positive and negative e.m.f.'s applied. All these facts tend to show that potassium vapour is ionised by ordinary light. A. W.

1303. *Probe-wire Measurements of Anode-fall of Potential.* **J. T. Tate and P. D. Foote.** (Washington Acad. Sci., J. 7. pp. 482–486, Sept. 19, 1917.)—In connection with some work in progress it was necessary to observe the amount of energy dissipated at the anode in a Wehnelt discharge tube. For this purpose a probe-wire was inserted in the anode glow and measurements were made of the current flowing and of the potential drop between the anode and the probe-wire. If the probe-wire circuit may be considered as obeying the ordinary laws of metallic circuits it might at first appear that the resistance between the probe and the anode is small enough to permit accurate potential measurements by use of a high-resistance voltmeter instead of an electrometer. It was found, however, that the voltmeter readings were quite different from the electrometer readings. Experiments undertaken showed that a film of high resistance forms at the surface of a probe placed in the anode glow. If a voltmeter were employed for the measurement of anode-fall, the readings would have to be corrected to allow for the potential drop through this high resistance. Such corrections would be impracticable on account of the varying nature of the film. Since the probe functions as an anode during voltmeter readings, evidence has been obtained for the existence of an anode polarisation similar to the polarisation at the kathode in a highly ionised gas, as observed by Skinner [Abs. 1004 (1917)]. The magnitude of the anode polarisation is very much less than that at the kathode. This explains the fact observed by Skinner that in an auxiliary transverse discharge through the kathode glow, the resistance and the current-potential curves are characteristic of the auxiliary kathode employed. A. W.

1304. *Distribution of Potential in a Corona Tube.* **H. T. Booth.** (Phys. Rev. 10. pp. 266–274, Sept., 1917.)—Since a knowledge of the distribution of potential between the electrodes will be necessary for any fundamental corona theory, an investigation has been carried out to determine the field at every point between a wire and a coaxial tube, under various conditions of impressed voltage, gas pressure, size of wire, and current. The distribution of potential was investigated by introducing an insulated wire radially through the side of the tube, the wire terminating in a bare spherical tip. An electrostatic voltmeter of small capacity was connected in series with the exploring point and the tube. When the wire is positive, the space between the anode and the kathode may, in general, be divided into four regions: (1) A region immediately surrounding the wire, which is characterised by a very large potential gradient. (2) A region of approximately constant force extending from the "surface layer" region adjacent to the wire, to a point which varies with the pressure, current, and voltage. At the higher voltages, the actual potential at a given point in this region is greater than the theoretical electrostatic potential, and the tangent to the curve may be either greater or less. (3) A region of little or no force near the tube. (4) A region close to the tube, corresponding to the "surface layer" contiguous to the wire, in which there is an abrupt kathode drop. When the wire is negative and corona appears, a potential curve is obtained which differs somewhat from the positive curves. Large kathode and anode drops appear, and the intervening space has a very small field. The anode and kathode drops of potential are thus predominant in both types of curves. Various reasons can be assigned for this: (*a*) Polarisation potential between a metal and a gas. (*b*) Accumulation of ions. (*c*) Reflection of ions. (*d*) Different velocities of positive and negative ions. (*e*) A non-uniform field.

From the curves obtained a graphical method was employed to deduce the radial distribution of the density of the charge. An attempt is now being made to formulate the mathematical theory of the corona discharge.

A. W.

1305. *Oscillatory Spark Discharges between Unlike Metals.* **D. L. Rich.** (Phys. Rev. 10. pp. 140–155, Aug., 1917.)—Many photographs of the oscillatory spark discharge between electrodes mechanically alike, but chemically different, were taken, in an attempt to determine whether or not the material of the electrode has any influence on the initiation of the discharge. Electrodes of copper, iron, zinc, and bismuth were used; also both alternating currents and intermittent direct currents were employed in producing the required potential differences. The photographs were taken on a film wrapped round a wheel 40 cm. in diam., which was driven at 2000 r.p.m., and a lens moving across the film caused the record of the discharges to trace out a continuous spiral of about 20 complete turns. Thus the spark-gap was under continuous observation for over half a second at a time, showing the groups of spark-trains in over 60 consecutive half-cycles in a single line photograph over 25 m. long. The relative number of spark-trains per half-cycle, and the relative number of sparks per train indicated that the Cu+ Fe− discharge takes place more readily than the Cu− Fe+ discharge. When the electrodes were alike, symmetrical discharges were always found. When the electrodes were of two unlike metals, decided rectification effects were always produced, being very pronounced when copper was one of the electrodes, and most prominent when iron was the other electrode. In other words, the material of the electrodes is not a negligible factor in the initiation of the discharge. If the discharge is electronic, the electrons are emitted from iron more easily than from bismuth or zinc, and much more easily than from copper, from bismuth more easily than from zinc, and from zinc more easily than from copper, so that the four metals can be arranged in a rectification series Fe, Bi, Zn, Cu. The rectification effects seemed marked and consistent throughout, whatever shape the electrodes might have. All the experiments were in air at ordinary atmospheric pressure.

A. W.

1306. *Indices of Refraction of Certain Solids for Short Electric Waves.* **H. Rubens.** (Preuss. Akad. Wiss. Berlin, Ber. 38. pp. 556–567, 1917.)—Electric waves of length 5·7 cm. (frequency $5{\cdot}2 \times 10^9$ per sec.) were generated by a Righi oscillator, collimated by a glass lens, reflected by a concave mirror and received on a resonator with iron-constantan thermo-element. The determination of the refractive index of the substance in the form of a paste is by an interference method modified from one in previous use by the author. The values are as follows :—

Substance.	Refractive Index.	Substance.	Refractive Index.
Quartz	2·10	Phosphate Crown (S.367)	2·51
Sylvine	2·17	Common Flint (0·118)	2·71
Rock Salt	2·40	Heavy Flint (0·255)	3·09
Fluor Spar	2·60	Heaviest Flint (S.461)	3·95
Marble	2·90	Ebonite	1·64
Fluor Crown (0·7185)	2·37		

[See Abs. 712 (1903).]

E. H. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1307. *Air-blast High-voltage Rectifier*. **E. R. Wolcott and C. J. Erickson.** (Phys. Rev. 9. pp. 480–488, June, 1917.)—It is well known that partial rectification occurs in a high-voltage alternating discharge between a point and a plate, but the resulting arc, especially with large currents, reduces the rectification to a very small percentage. The author finds that complete rectification and smooth operation are obtainable by aid of an air-current from the point to the plate. Apparatus is described which gives satisfactory rectification up to 350 kilovolts and at frequencies up to 500 cycles per sec. Curves obtained under different conditions are reproduced. A certain minimum voltage is required to jump the air-gap. The experiments were made on a 2-kw., 40,000-volt transformer. With 241 volts in primary, and 15,250 in the secondary, the rectified current was 25 milliamps. G. W. DE T.

1308. *Electrometer of High Sensitivity*. **G. Hoffmann.** (Ann. d. Physik, 52. 7. pp. 665–708, Aug. 16, 1917.)—Gives an outline of the theory of electrometers of the quadrant type and describes a form of instrument of high sensitivity employed for ionisation measurements. The needle has the form of a sector suspended at the point, and may be of Al or other light metal. The effects of temperature, degree of vacuum, insulation, etc., are considered.
J. W. T. W.

1309. *Dynamic Transformer for Alternating Currents*. **A. G. Rossi.** (Accad. Sci. Torino, Atti, 52. 15. pp. 696–707, 1916–17.)—Further experiments with a small model of the dynamic transformer previously described [Abs. 1158 (1916)] are here given, and its use as a telephonic apparatus (repeater or relay) is touched upon. This is to form the subject of a further communication. L. H. W.

1310. *Calibration and Constants of Emanation Electroscopes*. **O. C. Lester.** (Am. J. Sci. 44. pp. 225–236, Sept., 1917.)—Describes an examination of various types of electroscopes. The investigation is similar in character to that of S. C. Lind (U.S. Bureau of Mines, Tech. Paper No. 88; also Mineral Tech. 6. p. 17, 1915). The effect of mixing emanation with air at different pressures has been examined, and curves are given showing how the "activity" varies with pressure. A. B. W.

ALTERNATING CURRENTS AND MAGNETISM.

1311. *Demagnetisation of Iron*. **A. W. Smith.** (Phys. Rev. 10. pp. 284–290, Sept., 1917.)—To obtain the correct magnetisation curve for a piece of iron it is necessary that it should first be completely demagnetised. The paper contains the results of an investigation on a ring of Swedish iron (cross-sectional area 4·9 cm.^{2}) where various methods of demagnetisation were employed. In the first, the max. magnetising current of 1·5 amps. (H = 18·8 gauss) was reduced to zero and the ring subjected to a 60-cycle alternating current, initially 1·5 amps., and gradually reduced to 0·02 amp. It appears that only about ¼ of the residual magnetism is removed by this method. Better demagnetisation was obtained by employing a larger initial current (16 amps. corresponding to field of 200 gauss). Computation showed that about 10 times this current would be necessary completely to demagnetise the ring. As regards the B-H curve obtained after demagnetising with the alternating current, 1·5 to 0·02 amp., this is little better than that obtained by reducing the max. magnetising current to zero without reversal. The ring was also demagnetised by using direct current reversed by hand with a mercury commutator at the rate of one cycle per sec.; at the same time the current was slowly reduced from 1·5 to 0·05 amp. This process left $\frac{1}{3}$ of the residual magnetism undisturbed; it is affected also by the direction of magnetising current flowing before reversals begin. The incomplete demagnetisation by the above method is explained by the time lag in magnetisation. Eddy currents in the body of the iron shield the interior portions from the effects of such time cycles [see Abs. 677 (1917)]. The best demagnetisation was obtained by reversals at the rate of one every 10 secs. The magnetising current was reduced by 12 steps of such magnitudes as to diminish the induction by approximately equal amounts. At each step the current was reversed once in 10 secs. for ten times.

The author concludes that when a ring or other magnetic circuit is to be demagnetised, the time required for the magnetic flux to become fully reversed should be determined. This is done by closing the galvanometer key after reversal of the magnetising current and noticing what interval t is necessary in order that there should be no deflection. For complete demagnetisation, the current should not be reversed faster than once in $2t$ secs. This interval is not constant for the same ring, but is longer in the region of greater permeability. Faster reversals may be employed at the higher magnetisations. L. L.

1312. *Influence of Solar Activity on Lunar-diurnal Magnetic Variation.* **S. Chapman.** (Terrest. Magn. 22. pp. 87–91, June, 1917.)—New computations of the lunar-diurnal magnetic variations for five stations (Pavlovsk, Pola, Zi-ka-Wei, Manila, Batavia) have been made, using observations covering seven years for each station. These are compared with the variations of sun-spot numbers given by Wolfer for the period 1897–1903, and the resulting table of amplitude-ratios and mean phase-differences shows a parallel relationship for the solar and lunar variations, giving some further support to the theory that the lunar-diurnal magnetic variation is due to the combined influence of a lunar atmospheric tide and a solar ionising effect in the upper reaches of the atmosphere. [See Abs. 350, 1903 (1914).] C. P. B.

1313. *An X-ray Tube for Research Purposes.* **A. Muller.** (Archives des Sciences, 44. pp. 89–92, Aug., 1917.)—A detailed description is given of a specially designed X-ray tube. In ordinary X-ray tubes a considerable loss of intensity takes place due to several causes, namely: (*a*) bad focusing of the kathodic beam, (*b*) spreading (according to inverse-square law) after the X-ray beam leaves the antikathode and enters the air surrounding the bulb, (*c*) absorption on the glass walls of the bulb.

A tube is now described in which these losses are reduced to a minimum. The antikathode is a thin metal window, at the end of the tube, placed at the focus of the kathodic beam. The X-rays are emitted from this window into the air almost without loss. Such a tube gives special facilities for studying the softer X-radiations generated at low voltages.

As the surface area and volume of the tube are small, the vacuum can be obtained very quickly—in an actual case about 2 minutes for a "hard" tube. A. B. W.

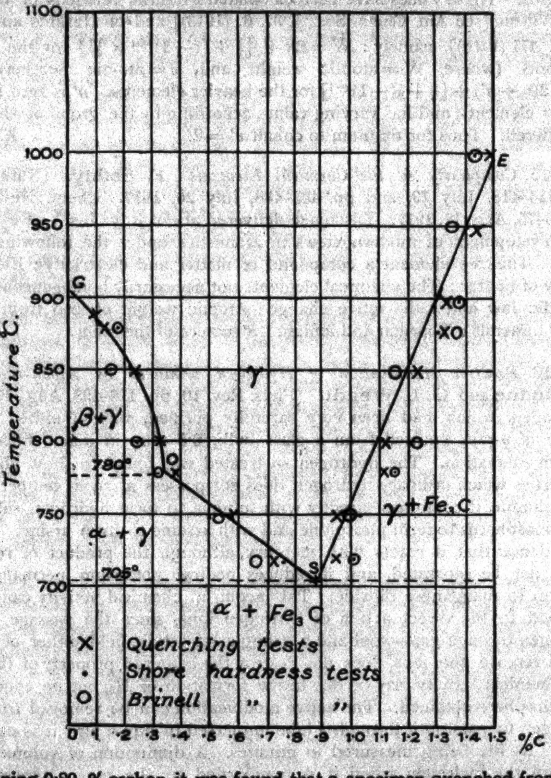
CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1314. *Numerical Relation of Atomic Weights to Atomic Numbers.* **R. G. Durrant.** (Am. Chem. Soc., J. 39. pp. 621–628, April, 1917.)—The paper contains tabulated values of atomic weights and atomic numbers of the elements. These values have been calculated from the relations of Harkins and Wilson [see Am. Chem. Soc., J. 37. 6. (1918)] and of Harkins and Hall [Abs. 471 (1916)], namely: $W = 2n + \{\frac{1}{2} + [(-1)^{n+1} \times \frac{1}{2}]\}$ for the lighter elements (where W = atomic weight and n = atomic number), and $W = 2(n + n') + [\frac{1}{2} + \frac{1}{2}(-1)^{n-1}]$ for the heavier elements. n' is zero for the lighter elements, and has varying values according to the group of elements considered. Thus for titanium to cobalt $n' = 2$. A. B. W.

1315. *Complexity of the Chemical Elements.* **F. Soddy.** (Nature, 99. pp. 414–418, July 19, and pp. 433–438, July 26, 1917. Chem. News, 116. pp. 73–75, Aug. 17, 1917. Discourse delivered at the Roy. Inst.)—Deals with the development of modern views in atomistics under the following main heads: The free element a compound of matter and electricity; Electrical theory of matter; The chemical elements not necessarily homogeneous; The periodic law and radio-active change; Atomic weight of lead from radio-active minerals; Thorium and ionium; Structure of the atom. L. H. W.

1316. *Reactive Modification of Hydrogen produced by Alpha-radiation.* **W. Duane** and **G. L. Wendt.** (Phys. Rev. 10. pp. 116–128, Aug., 1917.)—Hydrogen, which had been very carefully purified, was submitted to the action of α-rays emitted from a glass bulb, 0·5 mm. in diam., filled with radium emanation. The hydrogen so treated was found to show chemical properties which ordinary hydrogen does not possess at room temperatures. For example, it combines directly with sulphur to form hydrogen sulphide, with phosphorus to form phosphine and with arsenic to form arsine. There is evidence that it reacts with mercury, although the product of reaction could not be separated, and it reduces neutral potassium permanganate solution to manganese dioxide. This acquired chemical activity cannot be ascribed to the direct action of hydrogen ions, since the passage of the hydrogen through glass-wool and a strong electrostatic field, either of which would remove the ions, does not destroy the acquired property of the gas. The chemical activity may be due to the formation of H_3, but no conclusive proof has been obtained. The active modification can be removed from the hydrogen by passing it through a tube immersed in liquid air; it is not very stable, its life being measured in minutes. A diminution of volume takes place in the hydrogen when it is bombarded by the rays. Experiments designed to discover whether the formation of the active gas takes place during the actual bombardment by the α-particles, or subsequently, during the formation or disintegration of ionic clusters, were inconclusive. T. S. P.

1317. *Determination of the Curve of Transformation of Gamma Iron into Alpha and Beta Iron and of the Curve of Saturation of Gamma Iron by Cementite.* **P. Saldaou** and **P. Goerens.** (Russ. Met. Soc., J. 1. pp. 789–824, 1914. Rev. de Mét. 14E. pp. 65–74, March–April, 1917.)—A series of thirteen steels containing 0·11 to 1·54 % carbon have been quenched in water at 0° C., from temperatures ranging from 690° to 1000° C. in steps of 10 deg. after previously heating to 1050° C. The specimens were then examined microscopically for the presence of ferrite in hypoeutectoid steels and cementite in hypereutectoid steels and at any particular temperature the limiting point on the transformation curve was taken as corresponding to the mean carbon content of two consecutive steels, one of which showed a pure martensitic structure, while the other showed traces of cementite or ferrite after quenching from the temperature in question. With regard to the eutectoid steel containing 0·89 % carbon it was found that a specimen quenched from 700° was pearlitic, while a specimen quenched from 710° was wholly martensitic; therefore the temperature of the transformation of eutectoid steel has been taken as 705° C. This gives the GOSE curve of the iron-carbon diagram shown in the accompanying diagram. It is slightly higher than that determined by the method of thermal analysis.



The hardness values of the specimen were then determined by the methods of Brinell and Shore. In the Brinell test a 10-mm. ball under a load of 1000 kg. was employed. Hardness-carbon concentration curves plotted for the various temperatures showed discontinuities at the limits of the solid solution and these limiting values have been plotted on the diagram.

In a general way these points confirm the curves obtained by the microscopic method. Of the samples quenched from 1000°–780° C. the 0.67 % carbon steel showed the max. hardness while at 750° to 720° max. hardness was obtained in the 0·81 % carbon steel. Curves have also been plotted showing the relationship between the hardness and quenching temperature for the steels. In the hypereutectoid steels there are discontinuities in the curves corresponding to *Ar*3 and *Ar*2. The 1·54 % carbon steel attains its max. hardness on quenching from 830° C., at which temperature it consists of a mixture of cementite and the gamma solid solution. Quenched from higher temperatures the hardness is decreased, probably owing to the formation of austenite. F. C. A. H. L.

1318. *Formation of Troostite and of Martensite.* **P. Dejean.** (Comptes Rendus, 165. pp. 182–185, July 30, 1917.)—The experiments were made in the laboratory of Schneider's works with tool steels containing 18 % of tungsten and 4 % chromium. When this steel was heated up to 850° or 900°, the cooling curve showed a critical point A between 800° and 700°; when the initial heating was carried above 900°, A became less marked, and a second critical point B appeared near 400°; when the initial temperature reached 880°, A had disappeared, and B become much more pronounced. By changing the conditions of heating and cooling similar curves are obtained with self-tempering steels. The point A indicates the presence of pearlite or troostite, B the presence of martensite; when A and B occur together, both troostite and martensite are present, and this holds also for ordinary carbon steels. Quenched in oil or water steels of 1·13 or 0·74% C gave between 700° and 500° a point A and below 200° a point B. The conclusion drawn is that there is no discontinuity between the formation points of pearlite and troostite (A); both consist of aggregates of ferrite and cementite, but the pearlite encloses almost the whole of the carbon, the troostite only part of it. Below A the carbon, remaining in solution in the iron surrounding the troostite, remains in the state of austenite until at lower temperature (B) austenite is transformed into martensite. There is thus discontinuity in the formation of martensite and troostite which are of essentially different natures. In order to suppress the troostite and to obtain only martensite with a certain rate of cooling, the critical point must be exceeded by an amount which must be large when the rate of cooling is slow. It is as if in heating a steel above the point Ac, there remained germs of incompletely-destroyed carbide, which on cooling would facilitate the segregation of carbide as troostite. H. B.

1319. *Influence of Surface Tension upon the Properties of Iron and Steel.* **F. C. Thompson.** (Iron and Steel Inst., J., 95. pp. 155–174; Corres., 175–184, 1917.)—A further contribution [see Abs. 1098 (1916)], which is, however, not based upon any new experimental work. L. H. W.

1320. *Discussion on Methods and Appliances for the Attainment of High Temperatures in the Laboratory.* (Faraday Soc., Trans. 12. pp. 1–12. June, 1917.) —Consists of an address by **R. A. Hadfield**, a paper on "Recent Forms of Carbon Tube Furnaces," by **J. A. Harker**, and a discussion.

1321. *Cementation by Gas under Pressure.* **F. C. Langenberg.** (Iron and Steel Inst., J. 95. pp. 129–153, 1917. Engineering, 103. pp. 447–450 and p. 452, May 11, 1917.)—An electric furnace combining the requirements of a vacuum and pressure furnace in a single unit is first described, based upon a furnace developed by Hayes. With this furnace experiments were carried

out on carburisation and decarburisation, using both illuminating gas and acetylene. It was found that the gamma-beta points seem to mark a sharp break in the carburisation curves. No carburisation ensued below 720° C. The effect of pressure on the degree of carburisation was different at different temperatures. After a certain pressure is reached further increase of pressure will not cause additional absorption of carbon by the iron.
L. H. W.

1322. *Etching of Polished Surfaces at High Temperatures* in vacuo ; *Determination of the Curve SE in the Iron-Carbon Diagram by this Method.* **N. Tschischewsky** and **N. Schulgin.** (Russ. Mét. Soc., J. 1. pp. 457–469, 1915. Rev. de Mét. 14E. pp. 74–76, March–April, 1917.)—Polished specimens of steel containing 1·25 to 2·5 % carbon were heated *in vacuo* to various temperatures and etched by means of chlorine gas. Subsequent micro-examination indicated the temperature at which the cementite disappeared completely, this being the point on the line SE corresponding to that particular steel. The results indicate that SE is practically a straight line from the eutectoid point at 0·9 % carbon and 700° C. to the limit of saturation of the cementite in gamma iron at 1·7 % carbon and 1130° C. F. C. A. H. L.

1323. *Carburisation of Iron by Alkali Cyanides and Cyanates.* **Portevin.** (Comptes Rendus, 165. pp. 180–182, July 30, 1917.)—In superficial cementation iron and mixtures of alkali cyanide and ferrocyanides, to which sometimes oxidising salts are added, are heated to 800° or 900° C. in the presence of air ; in these cases cyanate is formed by oxidation. On the other hand the author had shown (*ibid.* 161. p. 305, 1915) that alkali cyanate decomposes under formation of cyanide between 750° and 900°. He now heats piano wires (about 5 gm.) embedded in a mixture of KCN and KCNO in various proportions (50 gm.) to 750° or 900° for 2 or 4 hours, and increases thereby the carbon percentage in the iron from 0·03 or 0·08 originally up to 2·19 maximum. The carburisation was very slight in cyanide alone, and most effective in mixtures containing from 25 to 40 % of cyanate, both at 750° and 900°. The addition of oxidising agents like potassium dichromate or nitrate to the cyanide and ferrocyanide would thus appear to be advisable for cementation only. H. B.

1324. *The Quenching of Steel.* **H. le Chatelier.** (Comptes Rendus, 165. pp. 172–174, July 30, 1917. Rev. de Mét. 14 pp. 601–608 Sept.–Oct., 1917.) —The recent researches of Portevin, Chevenard, Dejean [see Abs. 1051, 969 and 1318 (1917)] give the experimental demonstration of the quenching theory of André le Chatelier, 1895, which the author has always advocated against that of Osmond. The return to the magnetic condition is accompanied by a change in volume ; but the dilatation may not be the same when the transformation temperature is lowered as with slow cooling from 740°. The nature of martensite may be regarded as settled ; it is a solid solution of carbon in *a*-iron and differs from austenite in being highly magnetic. There remains some doubt as to troostite ; chemically it is a mixture of cementite and ferrite in very fine grains, physically identical with pearlite as to electric conductivity and density, but differing mechanically. Austenite always yields cementite and ferrite as lamellar or as submicroscopical pearlite ; martensite, when reheated to higher temperature, the granular sorbite of Osmond. When the austenite of an 0·8 % carbon steel is cooled at slow, moderate, rapid or enormously rapid rates, the respective final products are : pearlite, troostite, martensite, austenite ; the last case has only been realised for steels containing 2 % of Mn or of Ni. H. B.

1325. *Some Unusual Features in the Microstructure of Wrought Iron.* **H. S. Rawdon.** (Am. Inst. Mining Eng., Bull. No. 129. pp. 1845–1863, Sept., 1917.)—The structure of wrought iron as usually described by metallographists is that of a fairly pure iron. Impurities, if present, are considered as being in solid solution in the ferrite matrix or as forming part of the "slag streaks" present. Evidence is given that wrought irons high in phosphorus sometimes show a peculiar mottled or banded intracrystalline pattern, which by comparison with alloys of pure iron and phosphorus is shown to be due to a non-homogeneous diffusion of the phosphorus. The examination of a specimen from a piece of wrought iron which had failed in service showed that the break bore a definite relation to such banded markings and apparently was largely determined by them.

By the non-homogeneity in the distribution of phosphorus throughout the ferrite crystals, the ill-effects of phosphorus may be much enhanced. The examination of a series of wrought irons showed that such features are not to be regarded as common. Many poor grades of iron may be unsuitable for other reasons.

A second type of markings is described and illustrated—the well-known Neumann lines; these are shown to bear no apparent relation to the other variations in structure described. C. O. B.

1326. *The Supposed Reversal of Inheritance of Ferrite Grain-size from that of Austenite.* **H. M. Howe.** (Am. Inst. Mining Eng., Bull. No. 129. pp. 1865–1867, Sept., 1917.)—Gives data to show that the ferrite of low-carbon steel and of electrolytic iron, like the network of hypo- and hyper-eutectoid carbon steel, inherits, either absolutely or relatively, the grain-size of the austenite from which it is formed during cooling through the transformation range.

This evidence throws some doubts on Jeffries' hypothesis of what the author calls reversed inheritance, based on Ruder's observation that the grains of pressed pure electrolytic powder were coarser after heating to 1000° C. than after heating to 1300° C. C. O. B.

1327. *Formation of Diamonds.* **O. Ruff.** (Zeits. Anorg. Chem. 99. pp. 73–104, May 15, 1917. Engineering, 104. p. 287, Sept. 14, 1917. Abstract.)—An account of systematic researches extending over 3 years, interrupted by the war and not likely to be resumed. The object was to re-examine and supplement all methods likely to lead to a deposition of carbon as diamond, and in particular to ascertain whether such deposition would take place on small actual diamonds introduced which would then increase in weight. The results were on the whole negative, though very small crystals and very small growths were observed in some cases. After freeing the apparent diamonds produced of any amorphous carbon and graphite, and further of carborundum, alumina and silica (impurities possibly introduced by the use of carbon electrodes and in other ways) by means of treatment with acids (hydrofluoric, nitric, sulphuric, hydrochloric), and finally with chlorine (free of oxygen) at 1000°, there was not sufficient residue left for any crucial tests, and the experimenters had mostly to rely on density tests (sinking in acetylene tetrabromide) and fluorescence under ultraviolet and α-ray radiations; some residues completely disappeared when finally treated in oxygen. Many methods were tried. Gases (illuminating gas, acetylene, methane, carbon tetrachloride, carbon monoxide, etc.) were heated alone or together with vapours (iodoform, carbon disulphide, benzene, etc.) for days and weeks at temperatures ranging from 200° up to 800°, and even 3500° (arc); the arc of 0·5 amps. at 5000 volts alternating burning momentarily in liquid air yielded minute crystals; the arc burning in a powerful spray of water and singing arcs did not give any distinct diamond, though fusion of the carbon to a combustible hard mass did take place. Experiments with solid hydrocarbons and other compounds (wax, paraffin, pitch, graphitic acid, diphenylamine) to which various catalysts (mercury, amalgam, sodium, silicon, alumina, uranium oxide, etc.) were added were not successful. Quenching of metals (iron, alone or alloyed with various percentages of Si, Ti, W, V, Co, Ni, Mn) did result in formation of small diamonds; but alloys of low melting-points (*e.g.* an alloy of 100 parts of Fe, 100 Sb, 60 to 75 Mn, melting at 850° and Wood's-metal) were resultless. A complex silicate like the blueground of Kimberley did not yield anything; the electrolysis of fused calcium carbide at 2000° (Boismenu) seemed successful, but the crystals obtained did not survive prolonged purification. Finally experiments were made in a steel bomb after Johnston and Adams [Abs. 1024 (1911)] under hydraulic (or gas) pressure of 8000 atmos. with arcs or carbon rods, heated by the current in oil, benzene, water, CO. A carbon rod, 1·5 mm. in diam., heated in water was burnt through by a current of 35 amps. at 80 volts in 5 secs., but the bead of fused carbon solidified merely to graphite. In oil, benzene, and CO so much carbon was deposited about the rod that short-circuiting stopped the experiments. The experiments of A. Ludwig [Abs. 872 (1908); Chem. Zeitung, p. 266, 1914, could not be repeated; the action of the vapours from amalgams on hydrocarbons [W. v. Bolton, Zeits. Elektrochem. 16. pp. 667–669, 1910; and Abs. 88 (1912)] did not yield diamonds. H. B.

1328. *General Discussion on Refractory Materials.* (Faraday Soc., Trans. 12. pp. 86–273, June, 1917.)—Commences with an introductory address by **R. A. Hadfield,** followed by papers on "Refractory Material," by **F. J. Bywater**; "Texture of Firebricks," by **J. W. Mellor**; "Texture of Unfired Refractories," by **R. Lessing**; "Silica as a Refractory Material," by **C. Johns**; "Thermal Conductivity of Materials Employed in Furnace Construction," by **Ezer Griffiths**; "A Carbon Tube Furnace for Testing Softening Points of Refractories," by **Ezer Griffiths** and **E. C. Griffiths**; "Deterioration (and also Standardisation) of Refractory Materials in the Iron and Steel Industries," by **H. B. Cronshaw**; "The Common Refractory Oxides," by **R. B. Sosman.** Then follow appendices on standard specifications for refractory materials, taken from the reports of the Refractory Materials Committee of the Institution of Gas Engineers and the Society of British Gas Industries. L. H. W.

1329. *Drops and Columns of Crystalline Liquids with Twisted Structure.* **O. Lehmann.** (Ann. d. Physik, 52. 7. pp. 736–760, Aug. 16, 1917.)—In narrow capillary tubes, columns of crystalline para-azoxy phenetol, sufficiently liquid to form drops, can be obtained, which possesses a screw-like structure as a result of admixture with small amounts of other substances. The sign of rotation of the screw, the axis of which coincides with the axis of the tube, depends on the nature of the admixed substance, and the pitch on its amount. For cholesteryl benzoate and abietic acid, opposite signs of rotation are obtained. When these are both added, compensation occurs. Continuous transitions can be produced to the freely floating, strongly twisted crystalline drops. [See Abs. 1057 (1917).] A. F.

1330. *Thermodynamic Reversibility of the Equilibrium Relations between a Strained Solid and its Liquid.* **F. E. Wright** and **F. C. Hostetter.** (Washington Acad. Sci., J. 7. pp. 405–417, July 19, 1917.)—This paper offers experimental proof of the reversibility of the relations between a strained solid and its liquid. The mechanism of this action has been found to be exactly that postulated in 1862 by James Thomson from a purely theoretical basis, namely, that, on crystallisation, each particle (atoms and groups of atoms) enters into the crystal state in the condition of the crystal at the point to which it becomes affixed; and that if the crystal be under a state of strain the freshly deposited particle enters into the same state of strain. This fact is essential if equilibrium relations are to exist between a strained crystal and its liquid, because only under these conditions can the relations be strictly reversible, and thermodynamic reversibility is necessary if the thermodynamic equations are to be valid. It is interesting to note that the reversibility of the process has been questioned by Tammann and Pockels, while Nernst has defended the reversibility and considered that the thermodynamic treatment of such cases could be carried out exactly. Both experimental and geological field evidence are given in the paper, which prove the correctness of the assumption that the process, even for non-uniform pressure, is reversible. The direct lines of evidence put forward are: (1) Observations in plane-polarised light of the relative states of strain of an isotropic crystal, growing under load in a supersaturated solution, and the layers deposited on it. (2) Examinations under the petrographic microscopic of the relative states of strain, after removal of the load, of a crystal and the layers which were deposited on it while it was under load. (3) Examination under the petrographic microscope of the state of strain of certain minerals in rocks—such as schists, gneisses, quartzites—which geological field evidence proves were in part crystallised under load. Less direct proof is afforded by experimental evidence on the relative rate of growth and the increased solubility of crystals under load, and also by the directive influence of lines of thrust on the direction of maximal rate of crystallisation. The method of observation employed in the experiments was essentially that first used by Brewster in measurements of the relative strain in glass. Experimental details are given at some length, together with an illustrative diagram.

H. H. Ho.

1331. *Potential of the Lead Electrode.* **G. N. Lewis** and **T. B. Brighton.** (Am. Chem. Soc., J. 39. pp. 1906–1912, Sept., 1917.)—The authors have determined the potential of lead in solutions of lead iodide, bromide, chloride, and sulphate. An old sample of pure stick lead gives the same potential as lead freshly deposited by electrolysis, either upon lead or upon Pt. This behaviour is attributed to the softness of the lead and the consequent freedom of the metal from surface strains, to the existence of which the authors attribute the lack of reproducibility in electrodes of other solid metals. The authors found also that the same potential was obtained when liquid lead amalgams were employed, and in view of the greater convenience in using these, the actual experiments were carried out with amalgams containing about 1 % of lead by weight. The lead potentials in the presence of solid lead halides and solutions of the corresponding potassium halides were measured against the normal calomel electrode. From the measurements with lead iodide the normal electrode potential of lead is found to be 0·4125 against the normal calomel, and 0·1295 against the normal hydrogen electrode. The solubility of lead iodide has also been re-determined. From the e.m.f. measurements the true solubility products of lead bromide and lead chloride are obtained, and these are found to differ greatly from those which would be calculated by ordinary methods. For lead bromide the solubility product is calculated to be $1 \cdot 77 \times 10^{-5}$, and for lead chloride $4 \cdot 51 \times 10^{-6}$. From measurements of the temperature coefficient (between 20° and 25°) of e.m.f. the heat of solution of lead in mercury was calculated to be, in two experiments, 2940 and 2650 cals. Brönsted has found 2700 cals. For the heat of formation of lead chloride the value — 84,000 cals. has been calculated. A. F.

1332. *Electrolytic Valuation of Iron Sulphide.* **H. Williams.** (Chem. News, 116. pp. 13–14, July 13, 1917.)—The iron sulphide to be valued is dissolved in hydrochloric acid in the presence of zinc, free from sulphur. The hydrogen sulphide evolved passes into absorption flasks containing a solution of cadmium chloride. The precipitated cadmium sulphide is collected, dissolved in dilute hydrochloric acid, and the excess of acid neutralised with sodium hydroxide. A slight excess of sodium hydroxide is then added and the precipitate dissolved in potassium cyanide. From the solution thus obtained the cadmium is deposited electrolytically on a rotating kathode, and hence the percentage of ferrous sulphide in the original iron sulphide can be ascertained. T. S. P.

1333. *Electrolysis of Fused Cerium Chloride.* **M. de K. Thompson.** (Met. and Chem. Eng. 17. pp. 213–215, Sept. 1, 1917.)—Accounts are given of a number of attempts to obtain cerium by the electrolysis of fused cerium chloride under different conditions. The best results are obtained as follows: The electrolysis is started by fusing a little cerium chloride in an iron pot forming the electrolysing vessel, and which acts as the kathode, or in a Dixon graphite crucible from which it is poured into the iron pot. The graphite anodes, when first immersed in the fusion, should be hot, in order to prevent the salt from freezing round them and insulating the current. The fused chloride should form a layer about 2·5 cm. deep, and the anode should be immersed to a depth of about 1·7 cm. The pressure across the electrodes should be about 10 volts, the current for a pot with one 5-cm. anode then being between 250 and 300 amps. If several anodes are grouped together, the current carried by each should be somewhat less. The pots should not be heat-insulated. As the metal is deposited the anode is raised and chloride added, either in solid lumps or fused; the electrolysis is interfered with to the least extent when the fused chloride is added. The cerium may be poured directly from the electrolysing vessel, or the fusion may be allowed to cool, the pot broken open and the metal separated from the chloride. In the latter case the metal is re-melted under sodium chloride and cast into bars in Acheson graphite moulds. The current efficiency is about 80 %. The chief difficulty appears to be in maintaining the correct temperature (no temperature measurements were made). If the temperature falls too low the fusion solidifies, whilst if it rises too high a black material is obtained which is possibly cerium chloride with very finely divided cerium distributed through it. T. S. P.

SCIENCE ABSTRACTS.

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